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THE WASTE OF SLAUGHTER AND THE RAGE OF FIGHT

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> Inhuman discord is thy dire delight,
> The waste of slaughter and the rage of fight.
> Jove to Mars—
> Homer's Iliad, Book IV

IT SEEMS particularly fitting at this time to talk about the military problems of thoracic surgery. This Association was founded at the close of World War I; only a few years ago we concluded a second major war, World War II, and are now enmeshed in another whose casualties are already over 106,000. Inasmuch as we shall probably continue in a military way of life for some years hence, I believe, therefore, we should assume certain responsibilities in the preparation of young men for their future tasks in the Armed Forces.

Military surgery is as old as man himself. At the siege of Troy the Greeks had two surgeons in their army and when one, Machaon, forsook his primary calling and was wounded while joining his fellows in arms to repel a particularly fierce assault by the Trojans, great consternation fell upon the Greeks lest they lose him:

> A wise physician skilled our wound to heal,
> Is more than armies to the public weal.
> Idomeneus to Nestor—
> Homer's Iliad, Book XI[1]

In his descriptions of the numerous battles in that matchless epic, Homer depicts the battle wounds and deaths with exquisite vividness and anatomic precision, and there is great drama, pathos, and exultation as he describes the mortal wound:

> Deep in his breast above the pap it went,
> Amid the lungs was fixed the winged wood,
> And quivering in his heaving bosom stood.
> Thoas—
> Homer's Iliad, Book IV[1]

From the Department of Surgery, Columbia University.

Presidential Address, Thirty-second Annual Meeting of The American Association for Thoracic Surgery, Dallas, Texas, May 8-10, 1952.

His lab'ring heart heaves with so strong a bound,
The long lance shakes, and vibrates in the wound,
Fast flowing from its source as prone he lay,
Life's purple tide impetuous gushed away.
Idomeneus slays the young Alcathous—
Homer's Iliad, Book XIII[1]

Then drew the weapon from the panting heart,
Its reeking fibers clinging to the dart.
Patroclus slays Sarpedon—
Homer's Iliad, Book XVI[1]

The age of hand-to-hand combat persisted for still another twenty-five hundred years. The only weapons to be added were the catapult and the crossbow.

In A.D. 1215, however, a new extremely potent and destructive agent appeared, destined to change the entire character of arms and of war itself. Although first introduced by Genghis Khan against the Chinese, gunpowder was first heard of in the West at the battles of Cressy (1246) and Agincourt (1415), where cannon and gunshot were employed.

The gunshot wound was first described by Brunschwig in 1497, and again a few years later by Vigo, as a poisoned or envenomed wound. This idea was finally dispelled by Peré, in 1536, when he observed that gunshot wounds dressed with simple emolients ran a far more kindly course than those treated by the standard method of cauterization with boiling oil. The surgery of gunshot wounds was stated with amazing clarity and vision by an Elizabethan surgeon, Thomas Gale, in 1586, and here is the very essence of débridement as we know it today. After proving that they were not poisonous per se, he says:

> And there are two intentions properly hereto belonging. The one is to deliver the wound of all such things as are not agreeing to nature. The other is restoring of such things as are lost or perished. I call things not agreeing with nature not only shot, iron, splinters, or slivers of wood, cloth, dust, oil, or such like; but also the clots of blood, matter, bruised flesh, and such like as have no society with nature. The restoring of that which is lost, is properly the office of nature, as to engender flesh, blood, and such like parts as are to be engendered. Notwithstanding the surgeon herein is Nature's minister, and shall labor to bring the part to his right temperature: and it so reduced to conserve it in the same estate.[2]

Again it was more than two centuries later that the next great advance in military surgery was made by an extraordinarily brilliant young French surgeon, Baron Dominique Larrey. Not only was Larrey a very great surgeon, but he was also a most able administrator and a military genius. He was a zealous advocate of prompt surgery for the seriously wounded, and strongly condemned the prevailing custom of leaving the wounded on the field until after the battle. Therefore, in 1795, during the Italian campaign, he introduced the "flying ambulance." This innovation consisted of two- and four-wheeled ambulances with companies of men trained as litter-bearers and in simple first-aid measures. They carried the wounded to forward dressing stations or ambulances, where the seriously wounded were operated upon and the lesser casualties evacuated to the rear. We thus see the germination of the three-point system of forward surgery: triage, early surgery for the non-

transportable wounded, and near-by rear installations for the transportables, which was responsible in great measure for the very considerable decrease in mortality in chest and thoraco-abdominal wounds in World War II. Larrey also noted that penetrating wounds of the chest with an opening larger than the glottis did badly. He therefore advised that these patients be placed on the wounded side to permit the blood to drain out and that the chest be closed, and described several such cases with dramatic improvement and recovery following this treatment. This was a truly notable advance in the surgery of penetrating wounds of the thorax, and the first recognition of the dangers of an open chest.[3]

Although an excellent English translation was available in 1814, the United States Army seems to have profited little from the observations of this remarkable surgeon. At the outbreak of the American Civil War there were two two-wheeled ambulances assigned to each regiment, but they were at the complete disposition of the Quartermaster Department; the result was that the Medical Department rarely, if ever, was able to use them. On the recommendation of the Sanitary Commission, William A. Hammond was appointed Surgeon General in 1862. He was a man of considerable vision and of great professional and executive ability, and promptly nominated Jonathan Letterman as his Inspector General. When this appointment was not confirmed by the Senate, he named him Medical Director of the Army of the Potomac. Together they accomplished a revision of the whole evacuation system based on the experience of Larrey, so that at Antietam all the wounded were collected within twenty-four hours. Furthermore, the type of sick and wounded reports instituted by them were later of tremendous value in compiling the Medical and Surgical History of the War of the Rebellion.[4]

In this war there were 253,142 wounds of which 20,607 (8.1 per cent) were in the chest.[5] This ratio of chest wounds to the total number has remained approximately the same in all the major wars during the past one hundred years, with the exception of World War I, when it dropped to 3.8 per cent for Great Britain and 2.5 to 5 per cent for the United States. This is quite inexplicable in view of the German, Russian, and French figures of 6 to 9 per cent. Again, in World War II our incidence was about 8 per cent.

It is difficult for us, ninety years later, to picture the status of surgery in the war between the States. Anesthesia was limited, antisepsis and asepsis undreamed of, our medical schools poorly organized and administered, there was scant dissemination and exchange of medical knowledge, there was no intern and residency training, and no order and system at all within the Army. The over-all mortality for 20,607 chest wounds was 27.8 per cent, and for 8,404 penetrating wounds 62.5 per cent, chiefly from hemorrhage and empyema. As to thoracentesis: "This operation was occasionally resorted to during the war to relieve the effects of effusion resulting from acute and chronic pleurisy; and, more frequently on account of effusions consequent on traumatic pleuropneumonia, or the lodgment of foreign bodies within the chest." One hundred twenty wounds involving the diaphragm are recorded; recovery was rare.

Of the major vessels, there were twenty-five ligations of the subclavian artery with five recoveries, and thirteen ligations of the axillary artery with thirteen fatalities. All died of secondary hemorrhage and sepsis, and in only two instances were *both* ends of the artery tied.[5]

As we proceed, we note that in 1892 a change in the type of arms occurred; the high-powered rifle replaced the old muzzle loader, and about the same time the jacketed bullet appeared with the thin steel, nickel, or copper jacket. The surgeon was the important figure in the Civil War, but after this he began to fade into insignificance with the rise of sanitation and preventive medicine. The vital necessity for these was emphasized during the Spanish and Boer wars, when typhoid was rampant and sanitation almost nil. Thus we find ourselves at the threshold of the twentieth century with modern surgery in its early formative years, and sanitation and preventive medicine just awakening. As we entered World War I, the treatment of wounds was not very different from that of the Franco-German War of 1870: dress the wound, drain, or occlude the part. We were completely unprepared for the extravagant use of artillery, high explosives, and high-velocity missiles that were soon manifest after the outbreak of war in 1914. Until that time the preponderance of wounds had been caused by bullets and low-velocity missiles. Now the pendulum swung the other way and 70 per cent of the wounds were caused by high explosives and high-velocity missiles.

Before the United States entered the war, Pierre Duval of the French Army made some important observations.[6] At the outbreak of the war it was taught that thoracic wounds should not be operated upon until after the patient had reacted from his initial shock. Duval, however, realized the dire results of this policy, and stated that the chief causes of death at the Aid Posts were hemorrhage and mechanical asphyxia due to an open thorax; he further noted that the septic sequelae of shell wounds were far greater than in those from bullets, which were fatal either immediately or else ran a relatively benign course. The mortality from the former was approximately 30 per cent, from bullet wounds somewhere between 5 and 15 per cent. In 3,453 hospital admissions in the Army areas the over-all death rate of admissions to field surgical units was 20 per cent, while the average mortality of chest wounds in the forward units of the field hospitals was 45 per cent. He realized that it was difficult to state clearly the indications for immediate operation, but urged that if signs of hemorrhage persisted, the wound should be promptly opened and the damage sought for and repaired, whether in the chest wall or lung. As débridement for wounds of the soft parts and extremities was already being practiced with considerable success, he stated that the lung and pleura were contaminated just like other wounds, and therefore the treatment should be the same. In one series of 500 cases of hemothorax, 195 were infected, and in a personal series of 193 of his own in the Battle of the Somme there were 49 bullet wounds with no infections and 144 shell wounds with 34 infections. He advocated further that all shell wounds and retained foreign bodies be promptly operated upon under local novocaine block, and that the chest be closed tightly without drainage. "As technique improves," he said, "the

general surgery of gunshot wounds is being applied little by little to wounds of the lungs. Let us dare to hope that those who follow in our steps may soon have many more numerous and more brilliant successes."

As we entered the war we had Duval's work upon which to build, plus the general experience of both the Allies and the Germans. In 1917 a Special Services Branch of the Medical Department was established with eight divisions.[7] In the American Expeditionary Force, General Orders 88, General Headquarters, 1918, was the first order setting forth this organization with a Director of Professional Services appointed and the positions of Chief Consultant of Medicine and Surgery specified. Partly because of the times themselves, and partly because of the epidemic of influenza with pneumonia and the existing epidemics in the Camps in the United States of measles and pneumonia, attention was focused chiefly on the treatment of infection, and this was particularly so as regards the chest, and, as we know, empyema became such a problem that the Empyema Commission was created.

There were only 4,595, or 2.5 to 5.6 per cent, of chest wounds listed of the total of 174,296 wounds.[8] Nevertheless, the mortality in this group was 24.06 per cent, and of the penetrating chest wounds alone, 47.7 per cent in the American Army (Tables I[9], II[10], and III[10]). All emphasis was placed upon the prevention and treatment of infection, particularly the latter. With the conditions as they were, and the hemolytic streptococcus and respiratory infections so prevalent, this was inevitable. Still, as we look back upon that era, it is somewhat perplexing that more attention was not directed toward the physiology and the spatial dynamics of the chest. Anesthesia, we realize, was still limited and blood transfusions, with the concept of blood banks, were just coming into being through the work of Captain O. H. Robertson,[8] but it was not until World War II that we were to appreciate the full value of both of these extremely important agents. At that time the indications for immediate operation of thoracic wounds were: (1) aspirating wounds, (2) large retained foreign bodies, (3) severe injuries of the bone, (4) complicated lesions of the diaphragm, (5) extensive hemorrhage and suspected infection—particularly anaerobic. A firm and airtight parietal closure was imperative.

TABLE I. BATTLE CASUALTIES WORLD WAR I

	NUMBER	PER CENT	DIED	PER CENT
Abdomen and pelvis	3,546	2.0	1,536	43.3
Thorax	4,595	2.6	1,105	24.06
Face	8,607	5.0	316	3.6
Genitals	798		69	8.6
Head	10,453	6.0	1,456	13.9
Neck	594		65	10.9
Spine	598		334	55.8
Back	2,553		308	12.0
Upper extremities	62,238	36.0	2,412	3.9
Lower extremities	78,032	44.7	5,722	7.3
Unspecified	2,282		146	6.4
Total	174,296			

Carter, B. N., and DeBakey, M. E.: Current Observations on War Wounds of the Chest, J. THORACIC SURG. 13: 271, 1944.

TABLE II. WORLD WAR I. HOCHE: REVIEW OF ELEVEN MILLION WOUNDS IN ARMIES OF GREAT BRITAIN, FRANCE, UNITED STATES, AND GERMANY

	NUMBER	PER CENT
Thorax	660,000	6.0
Mortality		56.0

Berry, F. B.: Treatment of Injuries to the Chest, Am. J. Surg. 54: 280, 1941.

TABLE III. WORLD WAR I. HOCHE: WOUND DISTRIBUTION IN 12,350 KILLED IN ACTION

	PER CENT
Head	47.0
Chest	20.0
Abdomen	11.8

Berry, F. B.: Treatment of Injuries to the Chest, Am. J. Surg. 54: 280, 1941.

Toward the end of the war in discussion in the Allied Medical meetings in Paris permanent airtight closure was considered imperative with control of pleural effusions by closed drainage so as to permit prompt pulmonary expansion. There was also a growing opinion in favor of open operation in the treatment of extensive hemothorax, particularly if massive clotting had occurred, though aspiration was the initial treatment when possible, as it was recognized that it led to early recovery and return to duty. The bad results or organized hemothorax were noted, and also the fact that about 25 per cent of the hemothoraces became infected; hence thoracotomy with mechanical pleural cleansing and tight closure was recommended. This might be done initially according to three methods: first, by mere débridement of the wounds of entrance and exit; second, by a formal thoracotomy at the site of election with repair of the wounds of entrance and exit; and third, with removal of foreign bodies and resection and suture of lung when indicated. At this time postoperative airtight drainage was advised as better than repeated aspirations, and early activity and ambulation recommended. Here we have at the close of the war a verisimilitude of the treatment adopted with such brilliant results in the war to come.

During these intervening years we forgot the lessons that came out of World War I and were so ably stated in the official medical history of that war, and until the advent of the sulfonamides we continued to concern ourselves with the treatment of empyema by aspiration, closed drainage, and irrigation by various methods, open thoracotomy, and the collapsing operations for chronic empyema. When this Association was founded empyemas, both acute and chronic, were so common and so much a part of the general surgical services that we debated whether or not they should be included in thoracic surgery.

Our civil injuries of the lungs and pleura were chiefly crushing or caused by bullets or stabbing with small instruments such as ice-picks. The same applied to the heart and the pericardium, and in this latter field significant contributions were made by Elkin[11] and Bigger,[12] who reported to the Association in 1935 and 1938. From his experience with a small group of patients with bullet wounds of the chest from the New York Police Department, Weeks[13] advocated prompt evacuation of the hemothorax and re-expansion of

the lung in order to assure early return to duty and avoid protracted invalidism. Also during this period we witnessed the enormous advances in anesthesia and the introduction of the sulfonamides, so that when war came to us in 1942 we were far better equipped than we were in 1917. In addition, and perhaps most important of all, our intern and residency systems were at a high stage of development, with many young men well trained and ready to take over where their predecessors had left off. Unfortunately, however, although whole blood transfusions were freely used in civil practice, we had neglected to read aright the significance of Robertson's work a quarter of a century earlier, and instead had been lulled into a sense of false security by false concepts of blood substitutes. Thus, as we entered World War II the whole emphasis was placed upon plasma and the so-called blood substitutes, and no preparations had been made for the use of whole blood in quantity.

WORLD WAR II

We were catapulted into the war in three theaters, each with distinctly different types of warfare, which in turn brought their own peculiar problems and diseases. In all, however, the causative agents of wounds were similar to World War I except that high explosives were the causative missiles in nearly 80 per cent instead of 70 per cent as in World War I. Fortunately, preventive medicine was at its best, so that there were no epidemics in the camps at home, nor did we have to contend with a world-wide epidemic of influenza. Pneumonia likewise had been on the decline for many years, and we had the sulfonamides as powerful therapeutic agents. From the start, therefore, we were not bothered by infection, but were able to focus our attention upon the proper surgical treatment of the wounds on an anatomic and physiologic basis with early closure and restoration to as nearly normal function as possible. It was realized from the start by the three Theater Consultants, E. D. Churchill, E. C. Cutler, and W. B. Parsons, that the best prevention for infection in wounds was the proper initial surgery. It was recognized very early, also, that plasma was no substitute for blood, and it is a matter of record that the various hospitals in the overseas theaters used an ever-increasing amount of whole blood in the treatment of their casualties. At first this blood was obtained from the hospital personnel and also from the convalescing and ambulatory patients. Colonel Churchill was well aware of the necessity for whole blood available in large quantity, and it was due to his persistence of effort that the first blood bank was established in Naples, which not only supplied fresh blood for the Mediterranean Theater, but also cared for the needs of the Seventh Army during its invasion of southern France and until its supply was taken over by the European Theater in November, 1944.

As regards injuries and wounds of the chest, under the guidance of Colonel Churchill attention became centered upon the lung rather than on the pleural space; the physiologic disturbances incident to wounding required prompt treatment, sometimes in the most forward hospital unit, and with extensive surgery when necessary. Emphasis was placed upon adequate resuscitation, prompt re-expansion of the lung, and rehabilitation of the wounded man, and in the communication zone chest centers were established for expert

reparative surgery and convalescent care, with the result that only about 11 per cent of those with thoracic wounds developed empyema.[14, 16] The indications for formal thoracotomy at initial surgery were: (1) continuing intrapleural hemorrhage, (2) wounds of the trachea or larger bronchi, (3) wounds of the mediastinal organs, (4) wounds involving the diaphragm, (5) presence of large foreign bodies in the pleura.[15] For the other wounds only a local débridement and aspiration of the pleura was performed. Decortication was done later as indicated in the empyema group and in the small remaining group of noninfected clotted hemothorax cases. Many in this Association contributed much to these brilliant results.

In the European Theater after the invasion a similar regime was followed. Chest centers were established in Great Britain under the direction of General Cutler, the Theater Consultant, and it was in one of these centers that Harken[16] made his great contribution to cardiac surgery, the safe removal of intracardiac foreign bodies.

Although the final statistics of World War II have not yet been published, in 20,000 chest wounds treated up to 1944 the mortality was 8.1 per cent.[9] Perhaps the treatment of thoracic wounds reached its zenith from the spring campaigns of 1944 to the close of the war, because it was at about this time that penicillin became available in quantity, blood banks in the United States and in all theaters were well established, and in the personnel of the hospitals and the auxiliary surgical teams were a large number of well-trained surgeons who had profited not only by their experience at home, but were now also veterans in the surgery of the trauma of war. It was with such a group that I found myself in the Seventh Army (Tables IV and V[9, 17]). In an analysis of over 55,000 wounds treated in the Seventh Army Hospitals from Oct. 1, 1944, to May, 1945,[17] the field hospital platoons treated 264 thoraco-abdominal wounds (5.3 per cent) and 1,675 thoracic wounds (33.6 per cent). In other words, wounds involving the thorax comprised 38.9 per cent of admissions to our most forward hospital units. On the other hand, the evacuation hospitals, and at times some of these were within a half mile of the field hospital platoon, rendered primary hospital treatment to 187 patients (0.4 per cent) with thoraco-abdominal wounds and 2,645 (5.3 per cent) with thoracic wounds—5.7 per cent of their admissions. This is an example of the proper proportion of the work load in these two types of hospitals. The total number of thoracic wounds amounted to 4,320, or 7.8 per cent of our wounded. Of the 1,675 direct admissions to the field hospitals, only 38.5 per cent required formal operative surgery, and 59 per cent were evacuated after resuscitation and aspiration to the evacuation hospitals; 2.5 per cent died before operation could be accomplished.

As might be expected, the mortality in these two field installations was entirely different. For the field hospitals the mortality of the thoraco-abdominal cases was 26.5 per cent (in the last 200 cases cared for by the Second Auxiliary Surgical group the mortality was 20 per cent), and 15 per cent in the evacuation hospitals, with an over-all mortality of 21.7 per cent. This

TABLE IV. PERCENTAGE OF WOUNDS ACCORDING TO CAUSATIVE AGENTS

WAR	BULLETS	HIGH EXPLOSIVE FRAGMENTS
American Civil	90.10	9.80
World War I		
British	38.98	60.70
American	28.06	71.62
World War II		
Russian	20.00	80.00
American	19.50	80.40
Fifth Army		82.67
Seventh Army		75.20
Korea		
U. N.		
Bullets, mortars, grenades	70.00±	

Carter, B. N., and DeBakey, M. E.: Current Observations on War Wounds of the Chest. J. THORACIC SURG. 13: 271, 1944.
Berry, F. B.: Treatment of Injuries to the Chest, Am. J. Surg. 54: 280, 1941.

TABLE V. MORTALITY FROM CHEST WOUNDS

	NUMBER	DEATHS PER HUNDRED CASES
American Civil War	20,607	27.8
World War I, U.S.A.	4,595	24.06
World War II, U.S.A.		8.2
U.S. Seventh Army	4,320	5.4
Thoraco-abdominal	451	21.7

Carter, B. N., and DeBakey, M. E.: Current Observations on War Wounds of the Chest. J. THORACIC SURG. 13: 271, 1944.
Berry, F. B.: Treatment of Injuries to the Chest, Am. J. Surg. 54: 280, 1941.

group comprised the most severe types of wounds, usually multiple and often with large fragments from high explosive artillery shells. The purely thoracic wounds, however, in the field hospitals suffered a mortality of *8.7 per cent,* and in the evacuation hospitals *3.3 per cent,* an over-all mortality in the Army hospitals of only *5.4 per cent.* As you will note, there has been no differentiation as to whether the wounds were penetrating, perforating, crushing, or from blast, as this was not considered when tabulating our figures. These statistics are similar in the hospitals in the forward zones, both in the Mediterranean and European theaters in the last year of the war and show marked improvement over the earlier statistics up to 1944. At that time our men were receiving the maximum of fire from the Germans, from artillery, land mines, and from the air, with the causative agent 82.6 per cent high explosive missiles in the Fifth Army[18] and 75.2 per cent in the Seventh Army.[17] The chief contributing factors, I believe, to this really amazing record were first, the training and skill of the many surgeons involved; second, the excellent resuscitation afforded us with the fine judgment bred only by experience and soundness of knowledge of the physiological needs of the human body; third, the skilled and effective triage by the division clearing stations; fourth, the fluidity of personnel exchange and the availability of expert surgical teams; fifth, the Consultant system; and sixth, the antibiotics and other antibacterial agents. This is a complete about-face from World War I, when it was believed that the antibacterials and antiseptics were of ultra-prime importance.

I have dwelt upon these results in the last year of World War II at some length. Although the official medical history of World War II has not yet been published by the Office of the Surgeon General, the whole conflict is fresh in the minds of many, and the many excellent articles that have appeared provide easy reference for the new generation of surgeons that has come upon the scene within the last six years. During this period also there has been far closer cooperation between the Officers of the Surgeon Generals and the civilian profession through the Society of Consultants of World War II, the Medical Advisory Council to the Secretary of Defense, the less formal surgical clubs arising from the war, liason between the Surgeon Generals' Offices and the medical schools, the Committee on Medical Sciences of the Research and Development Board, and with the establishment of the Section on Military Medicine by the American Medical Association.

KOREA

Nevertheless, when the Korean conflict began in June, 1950, there was neither preparation, available personnel, nor the necessary medical units. Therefore, those in charge, particularly in Tokyo, had to make the best of an extremely difficult situation. The field hospital with its three platoons had been abandoned in favor of the Mobile Army Surgical Hospital (M.A.S.H.), which was constituted to accommodate priority I surgical patients with the concept that it should be placed adjacent to the clearing station, as had been the field hospital platoon. Its personnel consists of a fixed complement of about twelve Medical and three Medical Service Officers. The Commanding Officer, a Lieutenant Colonel, is listed as an experienced surgeon of B grade. There were no auxiliary surgical teams, and for some reason these were no longer regarded in very high favor, as it was thought that the M.A.S.H. unit with its intrinsic personnel could handle existing situations without difficulty. The M.A.S.H. units were assigned to the Army Surgeon for attachment at the rate of one per division. These units, however, had never been assembled except on paper. Furthermore, as the war broke there was but one evacuation hospital in existence in the United States, hence the Surgeon of the Far Eastern command in Japan had to do his best with the meager facilities at hand. In addition to a lack of necessary units and the superb field medical organization that existed in 1944 and 1945, personnel had been pared to the bone, and many officers were in or just finishing residencies in the re-educational program of the Army. This happily provided a small nucleus of well-trained, capable specialists in the various branches of the medical profession.

Korea itself presented a special situation. It is a narrow peninsula with several high mountain ranges running north and south, and deep valleys in between. The mountains vary from a few hundred to seven or eight thousand feet in height, and are steep and in large measure barren. There are two railroads up the peninsula, one through the large central valley, and one along the east coast. The north and south roads followed a similar course and were not good; both were largely the work of the Japanese during their occupancy. There were almost no lateral communicating roads due to the terrain itself.

This forced all military traffic over these few roads and the two railroads, which soon began to deteriorate under the strain. In order to meet this desperate situation in the best manner possible, and in view of the fact that the United Nations Forces were in a movement of rapid retreat, something had to be done in a hurry. Therefore, M.A.S.H. units were hastily organized and blown up into small mobile evacuation hospitals as an emergency measure, so that each was theoretically able to care for two hundred patients, although at times they had six hundred. All patients passed through them on the way to the rear, thus creating a bad situation from the start in that these hospitals had to perform triage, priority I, and priority II surgery.[18, 19] Obviously, triage suffered somewhat, and priority II surgery suffered the most (Table VI).

TABLE VI. REPORT OF M.A.S.H., JULY 9-DECEMBER 31, 1950

Admissions		8,577
Patients operated		1,516
Number of surgical procedures		2,280
Laparotomies	221	
Thoracotomies	60	
Amputations	59	
Head cases	10	
Débridements	1,173	
Number of pints of whole blood used		1,298
Deaths		112

Modified from Bowers, W. C., Merchant, F. T., and Judy, K. H.: The Present Story on Battle Casualties from Korea, Surg., Gynec. & Obst. 93: 529, 1951.

At times great confusion prevailed, but with the able support of the Air Force and the Navy an excellent evacuation service was soon in operation, and hospital ships were dispatched to Pusan to function as stationary evacuation and station hospitals. The required personnel were gathered from the small group within the Regular Army, from those who volunteered for extended duty and certain doctors who were called in on an involuntary basis, either singly or as members of Reserve Units. The hospital system in Japan was expanded at the same time and ably though thinly staffed and, in order to assure the best possible care in the earlier months, emphasis was placed on evacuation. This was both easy and costly, however. Inasmuch as the planes were returning empty to Japan, Hawaii, and the United States, there was plenty of room for the wounded and ill, and unquestionably in the early days better care was available in those places than in the crowded hospitals of Korea. But at the same time many were evacuated who could easily have been kept either within the combat area or the forward part of the zone of communication had proper hospitalization been available. Selective, rather than total, evacuation with adequate combat medical organization and communication zone facilities is essential to conserve man power and morale within the fighting area. Mindful of these facts, and knowing also the magnificent record that had been established by the Medical Department in Korea in spite of what seemed at one time almost overwhelming obstacles, I arranged with the Surgeon General for a visit in December, 1951, to try to learn in what way we could be of further assistance and so report to you.

I traveled from the Battalion Aid Stations of the Marines through the hospitals of Korea, Japan, and Okinawa. First, I should like to give unreserved praise to the morale of all the troops, their superb logistical support, and the extraordinary work of the engineers in improving the roads and in cutting new roads so that now almost all, even those winding through the mountains, are two-lane highways for trucks. There was excellent spirit in all the United Nations Medical Units in all Corps areas, East and West, and the support and care rendered by these organizations, not only our own three Services, but also Norway, Sweden, Denmark, and India merit the highest praise. As you know, the front was quiet in December, and the surgeon of the Far Eastern Command was in a quandary as to what to do with his hospitals, which were admittedly out of position at that time with the M.A.S.H. units about twenty miles behind the lines, because should an armistice be agreed upon emphasis would be placed on caring for the returning American prisoners. On the other hand, if war were to continue, some re-arrangement of hospitals and additional personnel would be required.

Korea is a desolate and lonely place. From the standpoint of our medical units, each is more or less isolated, but the personnel are brought together once a month for medical meetings in each corps area. These have been a godsend, as communication between the units is difficult. There is little emotional drive to create enthusiasm, and all the men are looking forward to the time when they can leave Korea. This personnel has been held to a bare minimum; in December there were only 49 experienced general surgeons in fifty hospitals in the entire Far Eastern Command, and 13 experienced orthopedists and 2 neurosurgeons. These included the consultants both from General Headquarters and the Eighth Army.[20] The remaining 122 general surgeons were interns and men partly through their residencies, together with some who had been in general practice with an interest in surgery. The personnel of the M.A.S.H. units was so scant that there was little attempt at organization into teams. The problem was made still more difficult by the frequent shift in both officers and enlisted men. Both the theater and army consultants are doing almost superhuman work in covering the hospitals and instructing, attending medical meetings, and keeping up with their reports. In addition, they travel each month with the visiting Consultants from the States. The young men in all the hospitals are eager for informal discussions and talks about their work and problems. Some in the hospitals in the communication zone were requesting service in the Eighth Army units. This so impressed us that a policy was established whereby all new arrivals would first have service in the hospitals in the rear so as to indoctrinate them in the problems of forward surgery and the mistakes that might be made. After a period of several months they are then to be sent to the Eighth Army and its installations. It is believed that with this training they will do even better work in the combat zone. It has not been possible to adhere to the original organization of the M.A.S.H. units, with the result that some of the commanding officers are not surgeons at all, which thereby diminishes by one the already limited surgical personnel. Also some are not interested in teaching the

younger men on their staffs. The greatest deficiency that both my successor[21] and I found was ignorance of the pathology of the high-velocity wound, and the reason and necessity for careful débridement. By and large the major wounds, such as those of the abdomen and chest, were well cared for, although here again there was a failure to realize, and also to absorb from the teachings of the overworked consultants, the fundamental surgical principle that each compartment of the body must be cared for in wounds involving more than one area, such as thoraco-abdominal injuries and wounds involving the buttocks, rectum, and bladder. This, of course, resulted in complications that presented extraordinarily difficult problems. These were being so well handled by the surgeons in the rear hospitals that it was evident that they were frequently having to correct the deficiencies of the initial surgery.

It is not a function of this paper to go into the surgical specialties, but in passing I should like to pay tribute to the really outstanding performance of the neurosurgeons who already have two teams of doctors, nurses, and enlisted men, with a small amount of housekeeping equipment, in the forward areas and the Neurosurgical Center in Tokyo. I have never seen a group of patients so well, thoughtfully, and considerately cared for. As to our own work, there is a Thoracic Center in Tokyo Army Hospital which was well supported by the Chief of Surgery and ably conducted by the surgeon in charge.

I was somewhat disappointed in the attitude of some of the younger men in the forward hospitals that their time was being wasted and they were bored at being forced to concern themselves with the surgery of trauma. This was brought acutely to mind by one of my own residents who was about halfway through his residency and had been with a forward unit for eight months. He told me that he considered his entire time spent with that unit, which had always been extremely active, as just so much time wasted as regards surgery. I believe this attitude is the fault of us at home. Perhaps we should pause and consider if the definition of surgery as given by Theodoric in the thirteenth century is not just as true today, possibly more so, as it was then. He said surgery consisted of three parts: "(1) the joining together of broken parts; (2) the separation of parts unnaturally joined; and (3) the removal of whatever is superfluous."[22] Have we paid too much attention to the last two and neglected the first? Certainly the desire of all young surgeons today is to remove and remove until there is not much left, because somehow or other it seems to be more interesting to subtract than to restore. But is this a true criterion of the surgeon? I would remind them of the wisdom Dr. Nathan Green offered in his presidential address in 1924: "It is of a subtler quality of the mind to know when and when not to operate than to know the technique of procedure."[23]

Quite apart from battle casualties, in the first year and a half in Korea there were 22,000 road accidents.[24] In December last we had our one millionth death from the automobile, and during 1951, 93,000 were killed in accidents throughout this country and 9,100,000 were injured, at an economic loss of eight billion dollars.[25] Fatalities were four thousand greater than in 1950, and motor vehicle accidents now account for about thirty-five thousand deaths

a year. On the other hand, our one millionth death in war since the Battle of Lexington occurred on Sept. 4, 1951, in Korea.[26] With the exception of the formation of the Association for Trauma, which is becoming increasingly important, and committees of the American College of Surgeons and National Research Council, we tend to negate the treatment of trauma in our better teaching hospitals and not infrequently men will pass through an entire residency in general surgery without ever having to face the problem of the seriously injured patient. This was brought out somewhat forcibly two years ago at the oral examinations for the American Board of Surgery when two candidates presented themselves before another examiner and me. Each had a patient who had been struck by an automobile, and in each instance there was a fractured pelvis, a common enough injury on the roads or in industry. Both of these young gentlemen had graduated from good schools and had their residencies in teaching hospitals, still, it required a good deal of prodding and prompting on our part to get them to recommend any other treatment than that they would call an orthopedic consultation. The urological aspect did not enter their minds and, when asked about the possibility of bladder injury, why of course a urologist would also be called in consultation. When pushed to the point of what they would do themselves if the facilities of the medical center were not available, they each decided they would merely put a drain down to the opening in the bladder were it injured. I have recently had a conversation with another young man who had spent nine years in a residency in another of our teaching hospitals on the general surgical service, and when the same question was put to him as to how he would treat a seriously injured patient he said he would immediately ask for a consultation. In other words, it has become rather "old hat" to pay attention to reconstruction of the human body in anywhere nearly the same manner as to the "radical cure" of disease, with its necessary exenterations and dismemberments. I do not wish at all to maintain that this latter is not a most important part of our teaching, but I also believe firmly that we should re-orient our teaching of surgery so as to place increased emphasis on trauma and its various causes and pathology and treatment. I do not mean that one person should necessarily assume the entire responsibility, but I believe that everyone passing through our residency systems should have sufficient knowledge so that he can handle a given situation from the standpoint of initial surgery until he can get help. This means an understanding of the fundamentals of surgery, resuscitation, and restoration of anatomy and physiology in the different parts of the human body. As we are in an age of war, we should teach the pathology of trauma and healing of wounds, and the importance of comprehending the different types of causative agents and their sequelae.

War and trauma unfortunately will not decrease in the foreseeable future. It becomes, therefore, our responsibility to teach and emphasize the surgery of repair and reconstruction just as much as we teach the surgery of pathology and disease so that when our interns and residents enter military service or encounter disaster they will not be perplexed and bewildered at the devasta-

tion wrought on human frames by man and his machines, but will be prepared to treat their torn and wounded fellow men with sound knowledge of the fundamental principles of the initial surgery of wounds.

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FIBROSARCOMA OF THE BRONCHUS

Report of Three Cases Diagnosed by Bronchoscopy and Treated by Resection

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INTRODUCTION

PRIMARY fibrosarcoma of the lung is a most uncommon lesion, and neoplasms of this type of proved bronchial origin are extremely rare. In a recent review, Black[1] was able to find only five cases in the entire medical literature which he considered to fulfill the criteria of primary fibrosarcoma of the bronchus. He added one case of his own. In the same issue of the Journal in which Black's case was reported, Carswell and Kraeft[2] described an additional case which was diagnosed by bronchoscopy and treated by pneumonectomy. Those authors reported having found six previously described well-authenticated cases of primary bronchial fibrosarcoma. Finally, Curry and Fuchs[3] have placed on record the case of a rapidly-growing fibrosarcoma expectorated by a 13-year-old girl; it was believed to be of bronchial origin. However, the patient has survived for over four years, and the primary site has not been conclusively established.

Reports of pulmonary sarcoma are commonly encountered in the older medical literature, but it appears that a vast majority of the tumors so described were either carcinomas or lesions of lymphatic origin. As recently as the turn of the century, carcinoma of the lung was considered a rare tumor. For example, Rolleston and Trevor,[4] in 1903, found only two bronchiogenic carcinomas in 3,983 autopsies at St. George's Hospital. They invited attention to Passler's[5] figures which included sixteen primary carcinomas of the lungs and bronchi among 9,246 post-mortem examinations at the Breslau Pathological Institute. Of the patients studied by Passler, 1,000 died of malignant disease, 870 of them from carcinoma, but the percentage of lung cancer was found to comprise only 1.84 per cent of the primary epithelial tumors, and only 1.6 per cent of the total group of malignant disease in the series. Their own experience, and a review of the literature to that time, prompted Rolleston and Trevor to conclude that "primary malignant disease of the lung proper, whether of the body or root, is of the nature of sarcoma" and their belief appears to be fairly representative of the medical opinion at that time. Discussing reports in the medical literature of primary pulmonary carcinoma, those authors stated that "the conclusion is forced upon us that some of the older writers have wrongly named their cases"; it was their feeling that most of the reported cases were, in fact, sarcomas.

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Present experience indicates that the exact opposite situation actually prevails. It is now well established that primary bronchiogenic carcinoma is one of the most common of all internal cancers, being rivaled only by carcinoma of the stomach as the most frequently encountered malignant neoplasm in the male.[6, 7] Conversely, increasingly precise pathological studies have clearly shown primary sarcoma of the lung to be a variety of tumor seen only on the rarest occasions. Although it is generally accepted that there has been a real, rather than merely an apparent, increase in the incidence of primary carcinoma of bronchial origin during the present century, it is almost the unanimous opinion among present-day pathologists that a great majority of the large number of sarcomas of the lung reported in the earlier literature were in reality tumors of epithelial origin. Edwards[8] commented upon the rapid disappearance from the literature of reports of primary pulmonary sarcoma in the 1920's, and attributed this to Bernard's emphasis on the fact that more meticulous study would enable pathologists to differentiate the sarcomas from highly immature epithelial tumors. Adler[9] listed ninety cases of lung sarcoma in his book published in 1912, but could authenticate only a small minority of them. Reviewing his material, it is found that a lack of adequate pathological description makes it impossible to accept a single case of Adler's as representative of primary bronchial fibrosarcoma. Furthermore, Adler stated that he had never personally seen a primary sarcoma of the lung. The rarity of primary sarcoma of the bronchus in the experience of present observers is attested by the fact that Mallory,[10] in 1936, in reporting a case of spindle-cell sarcoma of the lung, believed to be primary, stated that it was the first such case encountered at the Massachusetts General Hospital in over 8,000 post-mortem examinations performed there up to that time. Three years later, Ellis[11] described a case of primary fibrosarcoma of the lung seen at the University of Kansas Hospital, and noted that it was the first found at that institution in 7,272 autopsies. Clinical findings are in close agreement with the necropsy statistics just given. For example, Oschsner, DeBakey, Dunlap, and Richman[12] reported 548 cases of primary pulmonary malignancy, of whom 195 underwent resection. In that series, only one sarcomatous lesion, described as a neurofibrosarcoma, was encountered. This experience closely parallels that described in other clinical reports.

LITERATURE

Ball[13] reviewed the literature on primary pulmonary sarcoma in 1931 and found reports of only fourteen cases which he considered to be adequately authenticated. He reported an additional case of his own. Six of the cases accepted by Ball, however, were "round cell sarcomas" and, therefore, probably should be classified in the lymphoblastoma group. A seventh case, described as "fibrochondroadenoma witht osteoid tissue" clearly cannot be accepted in the group of bronchial fibrosarcomas. Of the remainder, only the cases of Boschowsky[14] and Ball presented convincing evidence of being truly representative of fibrosarcoma. In each of these cases the pulmonary involvement was so extensive that it could not be determined with certainty whether the tumor arose

in a bronchus or from the pulmonary parenchyma or pleura. This also applies to additional cases reported by Mallory,[15, 16] as well as those of Scheidegger,[17] Klemperer and Rabin,[18] Lyssunkin,[19] and Stohr and Sachs.[20] The cases included in these reports were clearly fibrosarcomas of the lung, but again their widespread involvement of a lobe or an entire lung makes it impossible to classify them as primary fibrosarcomas of bronchial origin; their primary site must remain conjectural. The two cases recently recorded by Gray and Whitesell,[21] both pedunculated tumors attached to the lung only by a slender pedicle, while true fibrosarcomas of low-grade malignancy were almost certainly not primary in a bronchus. It appears likely that they arose from the pleura, or, possibly, from the pulmonary parenchyma. The case reported by Steward[22] showed a predominance of spindle cells and could possibly be classed as a fibrosarcoma, but some small round cells were also seen, and the author described the case as a "mixed cell sarcoma." That patient had a large mass involving the entire left lower lobe, and the exact site at which the tumor arose could not be determined. Rosenblum and Gasul,[23] in a report lacking in pathological detail, recorded a case described only as "sarcoma" encountered in an infant. They referred to the reports of Bjornsten[24] and Lehndorff,[25] who described *round-cell sarcoma* in children, aged 2 and 3 years, respectively. Rosenblum and Gasul reviewed the pediatric literature and found eleven cases of sarcoma occurring in older children. The conclusion appears warranted that all of these tumors were of the round-cell variety. Stout[26] encountered only four cases of fibrosarcoma of the lungs, pleura, or bronchi in the Laboratory of Surgical Pathology at Columbia University during the years 1907 through 1946. During the same period, a total of 362 fibrosarcomas in all locations were seen. Johns and Sharpe[27] reported a well-authenticated fibrosarcoma of the bronchus in an 18-year-old boy. Death occurred from respiratory complications before treatment could be instituted. Autopsy showed almost complete replacement of the right lung by tumor. A polypoid tumor mass extended along the right main-stem bronchus and into the trachea.

BRONCHOSCOPY

Bronchoscopic examination and biopsy has for years been standard procedure in the diagnosis of tumors of the lungs and bronchi. Although supplemented in recent years by studies of exfoliative cytology, it remains by far the most important single method of investigation by means of which the exact pathological nature of a suspected bronchial lesion may be definitely determined preoperatively. In spite of the widespread employment of bronchoscopy, with the diagnosis of countless cases of pulmonary carcinoma having been established by that means, the number of cases of sarcoma of the lung diagnosed by bronchoscopic biopsy is extremely small. In 1939, Baum[28] and his associates reported the case of a 29-year-old white woman who showed a polypoid lesion of the right main-stem bronchus. The diagnosis of spindle-cell sarcoma was established by bronchoscopic biopsy. Those authors reviewed the literature, and could find only one such case diagnosed bronchoscopically, that of Herrnheiser[29] (1935), although Jackson,[30] in 1930, mentioned two endobronchial

spindle-cell sarcomas diagnosed by bronchoscopic biopsy. Jackson's cases were neither illustrated nor described in detail, and no statement was made as to whether they were considered primary in the bronchus or metastatic lesions. No follow-up was given. In 1911 Kahler[31] described before the International Laryngorhinological Congress a patient upon whom direct tracheoscopy showed a mass completely obstructing the right main bronchus. The patient subsequently coughed up a fragment of tissue which was diagnosed histologically as myxosarcoma. The lesion was treated by cauterization through the bronchoscope, but the tumor recurred. The clinical report was brief and was not illustrated by photomicrographs of the tumor. Additional cases diagnosed by bronchoscopic biopsy have been reported by Mallory[16] (1938), and Pollak and associates[32] (1941), Lewis[33] (1946), Black[1] (1950), and Carswell and Kraeft[2] (1950). Reports of lymphosarcomas and other tumors of the round-cell type, such as those of Vinson[34] and Jackson,[30] have been excluded in that it is felt that these tumors arise primarily in the mediastinal and peribronchial lymph nodes, and involve the bronchi and pulmonary parenchyma only secondarily.

TREATMENT

The meager experience which has been acquired in the management of patients suffering from primary fibrosarcoma of the bronchus makes it clearly impossible to formulate a therapeutic program which can be statistically shown to be the most rational and effective method of dealing with these lesions. The few cases that have been reported have been treated in a variety of fashions from the most conservative to the most radical. The 13-year-old girl reported by Curry and Fuchs[3] received no treatment, since the exact source of origin of the expectorated bronchial fibrosarcoma was never determined. She has been followed for over four years and shows no evidence of recurrence. The case of Pollak and associates[32] was treated by bronchoscopic removal and fulguration. The patient was well at the end of two and one-half years. Baum and co-workers[28] treated their case by repeated bronchoscopic removal and massive irradiation. The patient received a total of 18,630 r units over a two and one-half year period. Death occurred two years and nine months after treatment was first instituted; post-mortem examination established pulmonary tuberculosis as the cause of death, and thorough examination of the affected lung, including careful study of the previous site of the bronchial tumor, showed no evidence of neoplasm. The case of Lewis[33] was managed in a similar manner; after bronchoscopic removal of the visible tumor his patient received 6,353 r units of irradiation. Two and one-half years later the patient was clinically well, and his chest roentgenogram was negative. Herrnheiser[29] reported a complete cure by irradiation therapy. The use of radon seeds and electrocoagulation have been suggested for this condition. The case of Herzmann[35] was treated by lobectomy. There was no sign of recurrence of the tumor thirteen months later. The lesion in the case reported by Divis,[36] also removed by lobectomy, was obviously metastatic in character, and no conclusions can be drawn from the behavior of his patient. Sweet[37] did a right lower and midddle lobe lobectomy upon a patient with a large solid tumor, shown on microscopic examina-

tion to be a fibrosarcoma which involved the pulmonary parenchyma in a very extensive manner. Although thought to be primary in the lung, the nonmetastatic character of the lesion was not definitely established. Connection with a bronchus was not cited, and one may assume that the widespread involvement of the lung made determination of the exact site of origin of the tumor impossible. The neoplasm recurred two years later in the thoracotomy incision, and there were metastases to the spine. In the case of primary fibrosarcoma of the bronchus reported by Mallory,[15] death from intrapulmonary hemorrhage occurred during exploratory thoracotomy performed by Churchill.[15] Right pneumonectomy had been planned. In discussing the case, Churchill suggested local bronchoscopic removal prior to pulmonary resection in order to clear the obstructed bronchus and thus make the lung more manageable at the time of definitive surgery. In a second case at the Massachusetts General Hospital, Churchill[16] removed the left lung for a large sarcoma of spindle-cell type which involved the pleura as well as the parenchyma, and in addition was adherent to small portions of two ribs. Segments of the two ribs were removed with the lung. The origin of this tumor is therefore uncertain; Mallory felt that it was probably primary in the lung. Graham performed a left pneumonectomy in the case reported by Black[1]; palliation was achieved for about six years, but the patient died of mediastinal recurrence six years and seven months later. Carswell and Kraeft[2] also performed a left pneumonectomy in their case. The operation was done in January, 1948, and the patient was free of symptoms and showed no evidence of recurrence at the time of their report seven and one-half months later. Harrington[38] performed pneumonectomy in six cases described as "sarcoma." Five of these patients died within two and one-half years, while the sixth was living without evidence of recurrence five years later. Of twenty-one "coin lesions" treated by resection by O'Brien, Tuttle, and Ferkaney,[39] one was diagnosed as "sarcoma." Details of the case are lacking. The patient died nine months later of a ruptured intracranial aneurysm. Complete post-mortem examination showed no evidence of recurrence or metastasis of the lesion. Edwards[8] reported three cases as "sarcoma of the lung," but the microscopic pathology was not described. Two were described as ossifying, and one lay at the periphery of the lung. One patient, who was considered inoperable, was treated by irradiation and was alive and well two and one-half years later, one died following operation, and the third survived in good health for at least two and one-half years following lobectomy. Three of the four cases seen by Stout[26] were followed, and all died of their tumor in less than one year. One of the three had proved metastases.

CASE REPORTS

CASE 1.—A. A., No. 472571. This 39-year-old white man was admitted to the University Hospital, Ann Arbor, Mich., on Dec. 18, 1940, complaining of a chronic cough productive of two to four tablespoonsful of whitish sputum daily, shortness of breath, and pain beneath the left scapula. He stated that chest roentgenograms taken elsewhere in June, 1939, had shown a left intrathoracic tumor. It gave rise to no symptoms, and observation was advised. Chest roentgenograms in November, 1939, showed no essential change in

the size of the lesion. Further watchful waiting was suggested. Roentgenograms in December, 1940, showed the tumor to be approximately four times its original size. There was also a left pleural effusion. Because of the rapid growth of the mass, hospitalization was urged.

Fig. 1.—(Case 1, A.A.) Posteroanterior chest roentgenogram taken Dec. 18, 1940, at the time of the patient's admission to the University Hospital. In this view the huge tumor obscures the lower two-thirds of the left hemithorax. Its rounded superior border is clearly shown but its inferior margin cannot be defined.

Fig. 2.—(Case 1, A.A.) Lateral chest roentgenogram taken Dec. 18, 1940, showing the tumor occupying the middle and posterior portion of the left lower chest.

Physical examination upon admission to the University Hospital was essentially negative, except for the signs of consolidation in the lower left chest. Routine laboratory studies were normal.

Posteroanterior chest roentgenograms (Fig. 1) showed complete obliteration of the lower two-thirds of the left thoracic cavity. In the lateral film (Fig. 2) the lesion was

seen to occupy a position in the middle and posterior portions of the chest. In this view it had a diameter of 8 centimeters. Chest films taken elsewhere approximately one year previously were reviewed. They showed a large, rounded, smoothly outlined, dense homogeneous shadow lying in the middle third of the left lung field as seen in the posterior-anterior projection. A companion left lateral chest roentgenogram (Fig. 3) showed the tumor to be centered at the junction of the middle and posterior thirds of the hemithorax. Its posterior margin lay on a plane with the anterior borders of the vertebral bodies. These observations showed that the mass lay within the left lower lobe.

The patient was bronchoscoped by Dr. John Alexander on Dec. 18, 1940. A lesion was seen in the proximal portion of the left lower-lobe bronchus, and this was biopsied. The following histologic report was made by Dr. C. V. Weller: "Beneath the bronchial mucosa there is a neoplasm composed of spindle cells with relatively scant cytoplasm. A *spindle-cell fibrosarcoma* having characteristics which indicate origin in a neurofibroma."

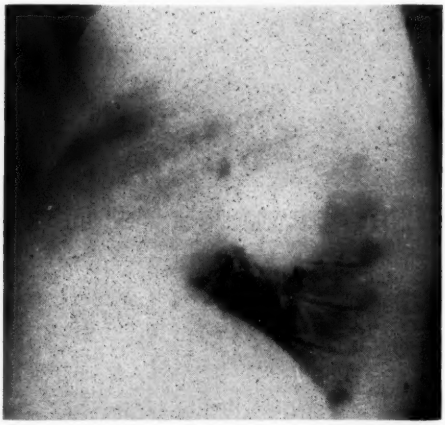

Fig. 3.—(Case 1, A.A.) Left lateral chest roentgenogram made elsewhere in November, 1939, showing the dense oval mass in the left lower lung field at the junction of the middle and posterior thirds of the chest. A posterior-anterior chest roentgenogram of the same date also showed the mass to be situated in the approximate center of the left lower lung field.

Left pneumonectomy was performed by Dr. John Alexander on Decc. 21, 1940. A huge tumor filling the lower three-fourths of the left hemithorax was found at operation. The upper lobe of the lung was collapsed, only the apical segment being moderately expanded.

The left lung and tumor weighed 1,450 grams. The tumor was soft, gelatinous, and white. The histologic diagnosis (by Dr. C. V. Weller) was: "*spindle cell sarcoma*" (Fig. 4).*

The patient's postoperative course was essentially uncomplicated except for a superficial wound dehiscence. He was discharged in good condition on the forty-second postoperative day.

The patient was readmitted to the University Hospital eight months later. He had remained free of symptoms until one month prior to his return, when he developed shooting pains in both legs. In addition, he had had pain in the cervical spine and stiffness of the neck. Dysphagia had recently developed. The patient also complained of diplopia.

*The histologic characteristics of these tumors will not be discussed or described in detail. They are being made the subject of a special study in the Department of Pathology, University of Michigan Hospital, and it is anticipated that this material will be published elsewhere at a later date. For an excellent discussion of the subject of fibrosarcoma, reference should be made to the article by Stout.[26]

Chest examination revealed the findings incident to a left pneumonectomy. Ophthalmologic examination showed paralysis of the lateral rectus, O.D.; vitreous opacities, O.S.; right convergent strabismus, paralytic. The patient was referred to the Department of Neurosurgery where the opinion was expressed that his symptoms were due to a general increase in intracranial pressure from cerebral metastases.

The patient's hospital course was steadily downhill. He required liberal opiates for relief of severe leg pain. There was intractable nausea and vomiting. He was discharged on Aug. 23, 1941. It was the clinical impression at that time that he was suffering from recurrent metastatic fibrosarcoma, and that the prognosis was hopeless. He died at his home in the fall of 1941, approximately ten months after left pneumonectomy. Post-mortem examination was not done.

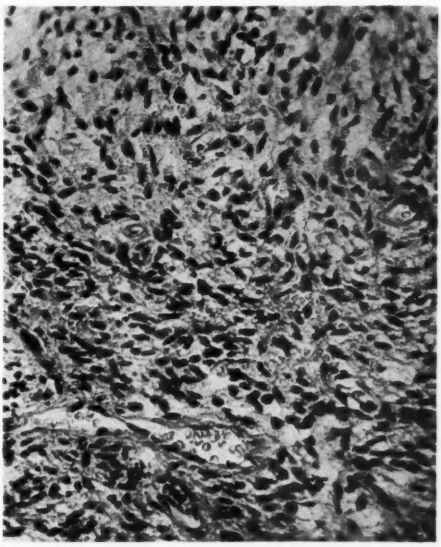

Fig. 4.—(Case 1, A.A.) Photomicrograph of the tumor. This lesion showed considerable variation in its microscopic appearance in different areas.

Comment.—The tumor in this case was so large and the pulmonary involvement so extensive that it was not possible to determine with certainty the exact origin of the tumor. However, it was proved by bronchoscopic biopsy to have *involved* a major bronchus. Whether it was primary at that site might well be debatable. Clinically and microscopically, the lesion in this case was indistinguishable from the neoplasms in the two succeeding patients in this report. Serial chest roentgenograms clearly showed that the tumor arose within the substance of the left lower lobe. In passing, one might once again point out the extreme danger of the policy of "watchful waiting" as applied to intrapulmonary lesions which are thought to be benign. This case exemplifies the wisdom of Alexander's dictum that "most intrathoracic neoplasms are not extrapulmonary and benign but intrapulmonary and malignant."[40]

CASE 2.—M. C., U.H. Reg. No. 651010. This 62-year-old white woman entered the University Hospital on Dec. 2, 1948, complaining of chronic cough of six months' duration. Her sputum had recently increased in amount and became more purulent in character. During the few weeks preceding admission she had raised small quantities of blood on several occasions. There had been slight weight loss and increasing ease of fatigue.

Physical examination showed slightly diminished expansion of the right chest when compared with the left. Tactile fremitus was increased over the right lower chest posteriorly and bronchovesicular breath sounds were heard anteriorly and posteriorly over the right lower chest. Chest roentgenograms showed evidence suggestive of atelectasis involving the right basilar segments (Fig. 5).

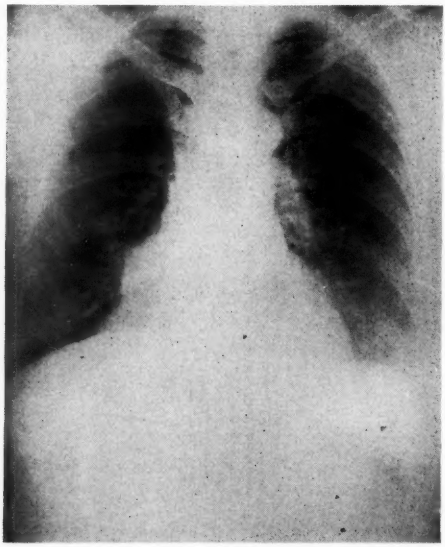

Fig. 5.—(Case 2, M.C.) Posteroanterior chest roentgenogram taken on Dec. 2, 1948, showing evidence of atelectasis of the basilar segments of the right lower lobe. A lateral film confirmed that impression.

Bronchoscopy was performed (by C. F. S.) on Dec. 12, 1948. The right main-stem bronchus was normal, but projecting upward from the bronchus intermedius to a point opposite the right upper-lobe orifice was a large, apparently pedunculated, fungating tumor mass whose basal attachment could not be seen. The visible extent of the tumor appeared to lie free in the bronchus, and it moved up and down the bronchus on respiration. Grossly, it was felt that this represented a bronchiogenic carcinoma. Biopsy specimens were taken from the projecting tip of the tumor mass. Frozen section examination was not diagnostic, but a malignant neoplasm was suspected.

Right pneumonectomy was performed (by C. F. S.) on the same day. At operation a mass could be palpated within the right lower lobe. It was firm to hard in consistency. Partial atelectasis of the right lower and middle lobes was present. The hilar nodes were uniformly soft and not particularly enlarged. Nevertheless, a thorough hilar node dissection was carried out.

The gross specimen was opened along the major bronchi and a firm, white pedunculated tumor mass of astonishing length was found. The sole point of attachment of the tumor was situated in the midportion of the medial basal branch bronchus. From this site it grew distally in the bronchus of its origin for a distance of about two centi-

meters. Superiorly, it extended into the main lower-lobe bronchus, thence upward to terminate opposite the right upper-lobe orifice. En route it sent out projections or pseudopods which partly or wholly occluded the orifices of the other three basal segmental bronchi, the bronchus to the superior segment of the lower-lobe and the middle-lobe bronchial orifice (Fig. 6). The histologic diagnosis (by Dr. C. V. Weller) was: "Pleomorphic *spindle-cell fibrosarcoma*" (Fig. 7).

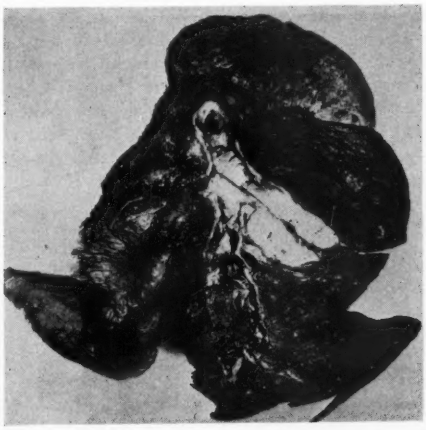

Fig. 6.—(Case 2, M.C.) Photograph of the gross specimen. The lung has been sectioned along the major bronchi. The intrabronchial tumor, yellowish white in color in the fixed specimen, formed an almost perfect cast of the bronchi in which it lay and sent out pseudopod-like projections into adjacent bronchi. It was actually attached by a very small base no more than 4 to 5 mm. in diameter in the midportion of the medial basal branch bronchus.

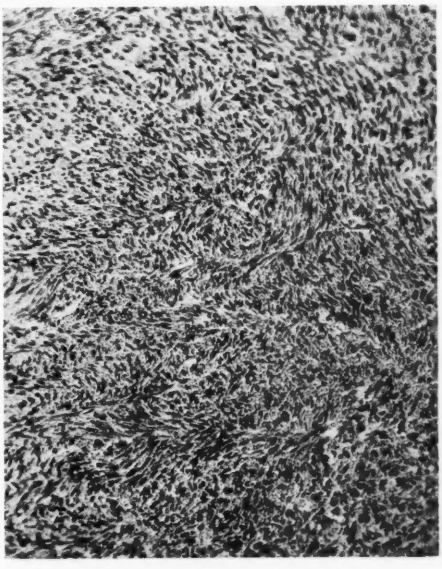

Fig. 7.—(Case 2, M.C.) Photomicrographs showing the microscopic appearance of the tumor. There was considerable variation in architecture in different portions of the tumor.

The patient's postoperative course was uncomplicated, and she was discharged on the fourteenth postoperative day. Chest roentgenograms eleven months later showed that she was developing overdistention of her left lung (Fig. 8). In November, 1949, a two-stage six-rib right posterolateral thoracoplasty was performed in order to shift the mediastinum back to the midline and to arrest the compensatory emphysematous changes taking place in the left lung. At the time of that admission there was no evidence of mediastinal or other recurrence of her neoplasm.

The patient's final admission was on March 28, 1950. She complained of pain in the occiput, the left shoulder, the left ear, and the left upper neck. She had recently developed progressive paresis of the left arm. Examination revealed cervical metastases. Spine films showed narrowing of the intervertebral foramina between C4 and C5, and between C5 and C6 on the left. A small hard node was palpable in the right axilla. This node was removed, and on histologic examination showed *spindle-cell fibrosarcoma,* apparently metastatic. A neurological consultant felt that there was involvement of the

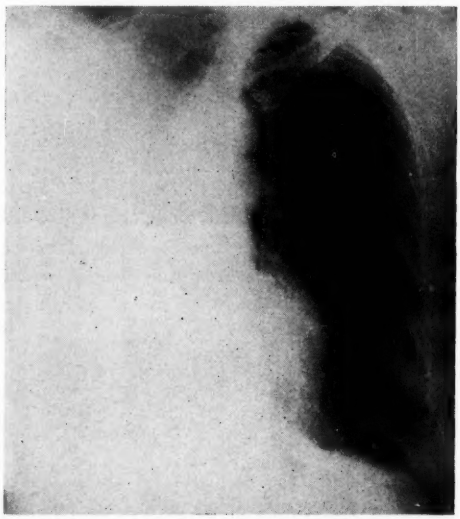

Fig. 8.—(Case 2, M.C.) Posteroanterior chest film made on Nov. 2, 1949, eleven months following right pneumonectomy for primary fibrosarcoma of the bronchus. There is considerable overdistention of the left lung. Note tracheal deviation. Lateral chest roentgenograms showed an anterior mediastinal hernia of moderate size.

brachial plexus on the left by a metastatic lesion. A posterior rhizotomy was performed bilaterally on the first through the fifth cervical nerve roots on April 30, 1950. At operation the suspected metastatic sarcomatous mass was found to be situated extradurally at the level of C5-C6. It was removed and on microscopic study showed *spindle-cell fibrosarcoma.*

The patient experienced considerable relief as a result of this surgical procedure, and she was discharged on May 22, 1950. However, her condition progressively and rapidly deteriorated after her return home, and she died on June 29, 1950, eighteen months after her pulmonary resection. An autopsy was not obtained.

Comment.—It appears well established that this patient's lesion was a primary bronchial fibrosarcoma. Careful and repeated search failed to reveal anything suggestive of a primary lesion elsewhere in the body. The gross appearance of the lesion (Fig. 6) did not suggest a metastatic tumor. The

metastases which occurred in this case, first becoming evident fifteen months following pneumonectomy, were probably via the blood stream. This case illustrates well the malignant nature of these lesions, and shows that distant metastases can occur even in the complete absence of local invasion.

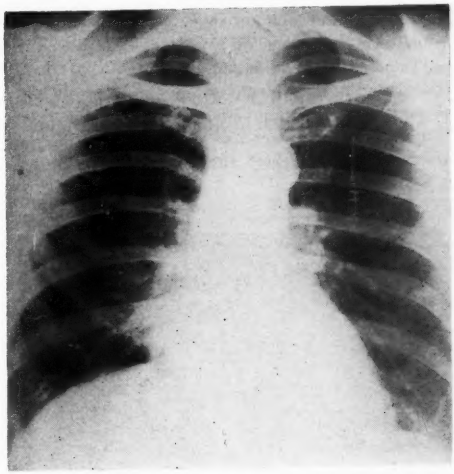

Fig. 9.—(Case 3, B.S.) Posterior-anterior chest roentgenogram taken May 9, 1949, showing suggestive evidence of partial atelectasis of the right middle lobe. Note elevation of the right hemidiaphragm.

Fig. 10.—(Case 3, B.S.) Lateral chest film taken May 9, 1941, which confirms the impression of partial atelectasis of the right middle lobe. The shrunken semiopacified middle lobe is well shown in this projection.

CASE 3.—B. S., U.H. Reg. No. 477699. This 41-year-old white woman was admitted to the University Hospital on May 9, 1949. She developed chills, fever, and malaise in December, 1948. Chest examination revealed a pneumonic process in the right mid-lung field. She had had several previous episodes of pneumonitis, and during an attack in January, 1949, a chest roentgenogram showed findings consistent with atelectasis of the right middle lobe. She was bronchoscoped in February, 1949, and a tumor was seen in the proximal portion of the right lower-lobe bronchus situated just distal to the middle-lobe bronchial orifice. Biopsies were taken and on histologic study (by Dr. C. V. Weller) were interpreted as showing a "moderately cellular *fibroma.*"

The pertinent physical findings were confined to the chest. The lung fields were normal on auscultation, but on percussion a triangular area of dullness in the right mid-lung field anteriorly was noted. Tactile and vocal fremitus were markedly increased in this region.

Radiographic examination of the chest showed atelectasis or partial atelectasis of the right middle lobe (Figs. 9 and 10).

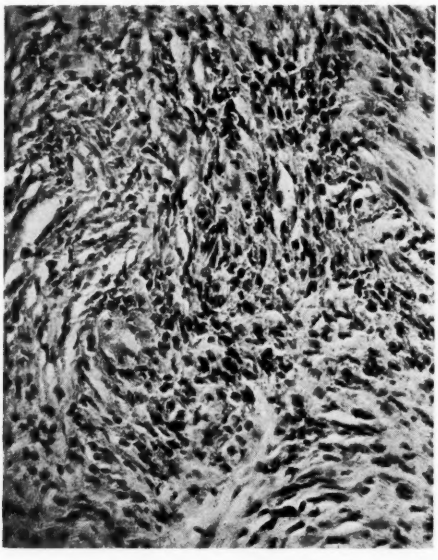

Fig. 11.—(Case 3, B.S.) High-power photomicrographs of the tumor showing the usual appearance of a low-grade fibrosarcoma.

Bronchoscopy was repeated by Dr. John Alexander. The previously mentioned tumor was again seen. It was situated in the most proximal portion of the right lower-lobe bronchus. The growth was dark red in color, and it appeared to completely fill the lumen of the bronchus. The middle-lobe bronchial orifice presented as a narrow transverse slit.

A right middle- and lower-lobe lobectomy was done by Dr. John Alexander on May 10, 1949. There were no abnormal-appearing mediastinal nodes, but several apparently normal nodes were removed from the hilar area for histologic study.

The surgical specimen showed a yellowish tumor one centimeter in diameter projecting into the lumen of the bronchus. There was atelectasis and bronchiectasis of the right middle lobe. The microscopic diagnosis (by Dr. C. V. Weller) was "*spindle-cell sarcomma*" (Fig. 11). The pathologic report stated that it "may have arisen from bronchial musculature. The neoplasm protrudes into the lumen of a bronchus and infiltrates around the cartilaginous plate. The regional lymph nodes contain no neoplasm."

The patient's postoperative course was uncomplicated, and she was discharged on the twelfth postoperative day. She has been carefully followed since her discharge from the hospital, and when last examined on June 12, 1950, fifteen months after her pulmonary resection, she remained clinically well. There was no evidence on roentgenogram (Fig. 12) or physical examination of recurrence of her neoplasm.

Comment.—This case appears to represent the smallest bronchial fibrosarcoma on record to be diagnosed by bronchoscopy and treated by resection. There is every reason to offer a favorable prognosis. This case illustrates the serious significance of recurrent bouts of pneumonitis, particularly when there is associated atelectasis. It also shows the extreme value of careful bronchoscopic examination in that type of case.

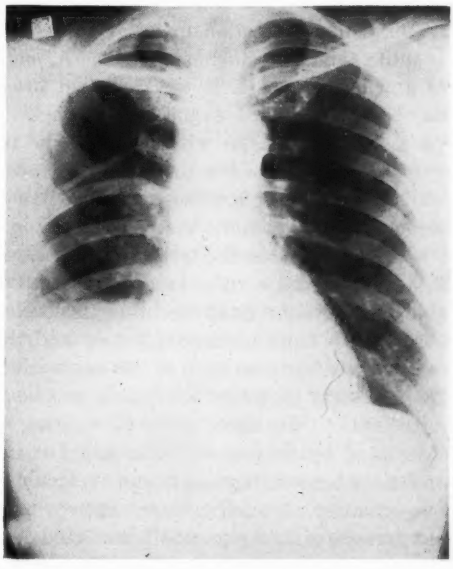

Fig. 12.—(Case 3, B.S.) Chest roentgenogram made May 8, 1950, one year after right middle- and lower-lobe lobectomy for fibrosarcoma of the bronchus and three months after resection of a segment of the right for suspected recurrence. On pathological study that lesion poved to be a benign chondro-osteoma.

DISCUSSION

Although it has been repeatedly stated that fibrosarcoma of the bronchus, in common with lesions of this type encountered elsewhere in the body, is a slowly-growing tumor, histologically well differentiated, spreading principally, if not exclusively, by local invasion, our own experience and a review of all well-verified cases reported in the literature lend poor support to that viewpoint. While exceptions have been noted, this entity has proved itself to be a highly fatal condition, usually causing death of the patient within two years or less from the time that symptoms first appeared. Case 2 illustrates that distant metastases can and do occur. Though not proved, similar spread doubt-

less occurred in Case 1. Despite the occasional success reported in the treatment of fibrosarcoma of the bronchus by conservative means, such as local excision through the bronchoscope followed by irradiation, it is impossible for me to subscribe to any such therapeutic regimen.

In the days when all intrathoracic operations constituted a grave risk there was perhaps some justification for avoiding resection therapy. At the present time, however, when resection of the lung can be undertaken with relative safety, halfway measures in attacking malignant disease of the pulmonary system scarcely seem defensible. It appears hardly appropriate to compare fibrosarcomas of the bronchus with bronchial adenomas in relation to therapy. I agree with Black,[1] who concluded that, in spite of the apparent success of endobronchial treatment in three reported cases, the therapy of bronchial fibrosarcoma must be by pulmonary resection in order to assure removal of all of the neoplasm. It is quite true that adenomas of the bronchus were long held to be benign lesions and on that basis it was felt that bronchoscopic removal constituted adequate therapy. Added experience showed, however, that these tumors often assume a dumbbell shape with much of the tumor invading the pulmonary parenchyma and inaccessible to the bronchoscope. Furthermore, it has been well established that these are low-grade carcinomas and that distant metastases sometimes occur. Pulmonary resection is being ever more widely accepted as the procedure of choice in the treatment of lesions of this character. Yet many bronchial adenomas cause remarkably little trouble for years, apart from that attributable to partial or complete bronchial occlusion. On the contrary, fibrosarcoma is a much more malignant tumor and the results of inadequate therapy so much more disastrous than is the case with the usual bronchial adenoma, that it does not seem that the two lesions can be fairly compared as to therapeutic requirements. We agree with those who feel that bronchial adenomas should be treated by pulmonary resection, but in the case of fibrosarcoma of the bronchus, whose malignant nature is doubted by no one, such therapy appears to be a matter of much greater urgency. I do not believe that these truly malignant tumors can be reasonably managed in any other manner.

There appear to be adequate grounds for divergent opinions as to the extent of pulmonary resection indicated for bronchial sarcoma. It might well be argued that in dealing with this lesion, as with malignant disease in general, only a truly radical operation, in this instance a total pneumonectomy with thorough dissection of the mediastinal nodes, would suffice. However, despite the evidence that these lesions, as a rule, behave in a definitely malignant manner, limitation of resection to simple lobectomy in the early cases can be defended on several grounds. Their rate of growth is relatively slow when compared, for example, with bronchogenic carcinoma. They most commonly spread by local invasion or infiltration. When distant metastases occur it is most likely to be by way of the blood stream. Lymphatic spread is much less common, although secondary growths may occasionally be found in the tributary lymph nodes. These facts would indicate that, in contradistinction to bronchial carcinoma, which usually spreads by way of the lymphatics, total pneumonectomy and radical mediastinal node dissection will be called for only

when a fibrosarcoma of bronchial origin is of such size and location that direct infiltration of the mediastinum may be reasonably suspected, or when, at the time of operation, the mediastinal lymph nodes are believed to be involved as a result of being found enlarged and of abnormal firmness. The finding of contained sarcoma cells in such a node following excision and examination by the frozen section technique would confirm the clinical impression and cause the surgeon to complete a thorough radical operation. However, even if one or more such nodes should prove to be negative, in the presence of the findings mentioned, a radical resection would probably be the wisest and safest course to follow.

SUMMARY AND CONCLUSIONS

1. Primary fibrosarcoma of the lung is a rare disease and lesions of this type arising in a bronchus have been reported in only a few instances.

2. A review of the literature indicates that primary bronchial fibrosarcoma has been diagnosed by bronchoscopic biopsy in only seven previously reported cases.

3. The small number of these lesions which have been encountered makes impossible the formulation of rational plan of therapy on the basis of experience.

4. In view of the malignant nature of this disease and the utter impossibility of determining by bronchoscopic observation the extent of its penetration into the lung, pulmonary resection is surely the therapy of choice. The known tendency of fibrosarcomas to be relatively radioresistant strengthens this opinion. Even though an occasional tumor of this type might prove to be partially radiosensitive, present concepts in the management of malignant pulmonary disease do not make acceptable the leaving of resectable sarcomatous tissue in situ and dependence upon irradiation for its control.

5. Three cases of fibrosarcoma of the bronchus which were diagnosed by bronchoscopic biopsy and treated by pulmonary resection are reported. Two of the three cases are considered definitely to have arisen primarily in a bronchus; the lesion in the third case involved a major bronchus, as proved by bronchial biopsy, but at the time of pneumonectomy the exact site of origin of the huge tumor could not be determined with certainty. Although not susceptible to proof because of the advanced state of the lesion at the time of resection, a primary bronchial origin of the lesion in that case is considered most probable.

6. Of the three cases reported herein, one patient was seen late in the course of his disease after his tumor, relatively small when first discovered, had been "watched" elsewhere until it had become huge. The extensive pulmonary invasion at the time of operation made total pneumonectomy mandatory. Palliation lasted for only a few months. Although not proved histologically, there was conclusive clinical evidence of early recurrence and distant metastases. Death occurred about nine months after resection. The second patient sought medical attention late and she also was treated by pneumonectomy although, in retrospect, it is felt that a right middle- and lower-lobe lobectomy might have been a satisfactory procedure. Palliation in that case was achieved for fifteen

months when signs of multiple distant metastases became evident. Death from metastatic fibrosarcoma occurred eighteen months after pneuonectomy. The third patient with a primary bronchial fibrosarcoma was seen early when her lesion was small and apparently localized. Resection was limited to removal of the right middle and lower lobes. She is alive and appears to be well thirteen months after operation.

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MERCURY-BAG BOLUS TO EXPEDITE PASSAGE OF ESOPHAGEAL DILATOR GUIDE STRING

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GRADUATED dilators guided within the lumen of the esophagus by passage over a slightly tensed, previously swallowed string were introduced by Mixter[1] in 1909, and are now in common use for the treatment of esophageal strictures due to a variety of causes. Usually a bead or split lead shot has been utilized as a weight and bolus to pull the swallowed string caudad until the traversed loops of intestine offer sufficient resistance to anchor the string. While the shot or bead employed may be small enough to pass through the narrowed zone and down the gastrointestinal tract carrying the string, the passage at both the area of stenosis and within the gastrointestinal tract may be erratic and time consuming.

Borrowing from the experiences of others in the rapid passage of intestinal decompression tubes,[2-4] the substitution of a small mercury-laden rubber bag, or gravity director head, as the bolus for the esophageal dilator guide string has assured its passage more quickly and more consistently. We have used the mercury-bag bolus to expedite string swallowing only twelve times, but have been sufficiently impressed by the speed, safety, and reliability of this method to suggest its trial by others. Often the mercury-bag propelled string can be swallowed at night and esophageal dilatation accomplished the following morning. Occasionally the dilator string has been passed expectantly in this simple manner and used for active dilatation if a stricture was found at esophagoscopy or abandoned if no stricture was encountered, for the string in no wise interferes with esophagoscopy. By the weight of the mercury bag one is immediately aware of its passage through the stenotic area and, after proper positioning of the patient, its passage through the pylorus is frequently heralded, within a few minutes, by a sudden movement of the string. This eliminates the necessity of observation periods or roentgenogram determinations.

The mercury-bag bolus is used only as a means of carrying the string down the gastrointestinal tract, and is not intended to serve as a bougie. The bag is most effective when it contains a small amount of mercury, and is thus similar in its application to the "head" of the Cantor[3] intestinal decompression tube, which takes advantage of the mobility, lability, and great cohesive or ameboid characteristics of mercury. A convenient and reliable size for the bag is an ordinary rubber finger cot. Two cubic centimeters of metallic mercury are placed in the tip of the finger cot and no particular effort is made to expel air as the open end of the finger cot is closed by securely tying it to the end of the string to be swallowed. Sufficient air should be left within the finger cot

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to permit free motion of the mercury, but not enough air to form a buoyant balloon from the absorption of intestinal gases.[5] The increased tension within the balloon could cause obstructive symptoms.

Twelve feet of No. 2 braided silk suture is used routinely as the swallowing string. Usually there is adequate anchorage to tense the string after six to eight feet of it have been swallowed. In one instance, when dilatation was delayed for three days, the mercury bag presented at the anus in forty-eight

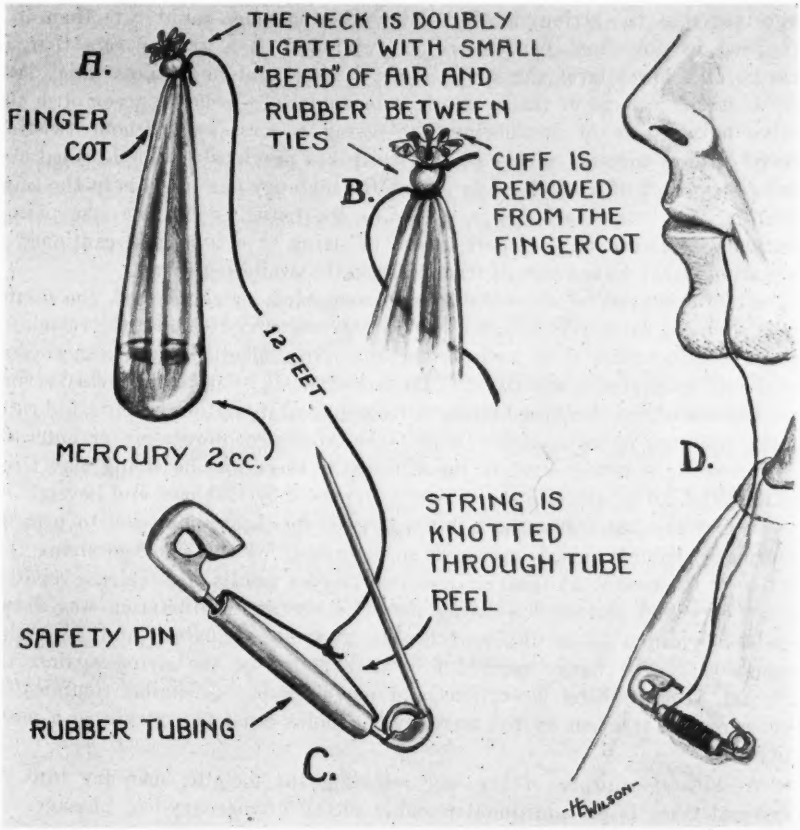

Fig. 1.—*A*, Rubber finger cot with mercury; *B*, detail of method of bag closure which has proved leakproof and secure; *C*, rubber tube reel on keeper shaft of safety pin, stretch to place: *D*, mercury bag may be passed through the mouth as here, or via the nose and the string recovered from the mouth at the time of dilatation.

hours and was cut free. The patient suffered no ill effects from this pleating of his intestinal tract, and the retained string was satisfactory for esophageal dilatation the following morning.

The mercury bag may be passed either through the nasopharynx or directly into the oropharynx as the patient prefers. The use of a water-soluble lubricant

is especially advocated in patients with esophageal stenosis and should be mandatory if a topical anesthetic has been employed. When the bag is felt to have dropped into the stomach the patient is placed on his right side, rotated slightly forward, in order to allow the bag to gravitate to the pylorus. Usually no further special positioning is necessary, once passage through this sphincter is accomplished.

Although a string travels more rapidly down the intestinal tract when drawn along by a mercury bag than by other means, nevertheless it is still important that the string not be swallowed at a more rapid rate than it is propelled by intestinal peristalsis. If swallowed at a greater rate than its passage at a lower level, the string tends to snarl and form knots which later may obstruct passage of the bougie it is to guide. In order to accomplish this individualized rate of swallowing, the string is wrapped, without twisting, around a short piece of rubber tubing which has previously been threaded over the keeper shaft of a safety pin. When the mercury-bag bolus is in the small intestine, this improvised reel is pinned to the patient's clothing, the patient instructed to loosen only a short length of string at a time, and cautioned to do this only when he is aware of traction from the swallowed string.

After dilatation of the esophagus is completed, or abandoned, the dilator guide string is cut low in the pharynx and the mercury bag with the remaining attached string allowed to pass per rectum. No difficulties have been encountered with spontaneous expulsion of the mercury-bag bolus and attached string.

The use of the swallowed string for esophageal dilatation is contraindicated in the presence of an anatomic loop (such as gastroenterostomy or enteroenterostomy, etc.) at any level in the alimentary tract for the string may circle the loop and cut or ulcerate the mucosa as reported by Hubbard and Leven.[6]

A mercury-bag bolus which is too large or too heavy may fail to pass the pylorus or, having passed, may pull so vigorously on the attached string that cutting of the nasopharyngeal or intestinal mucosa results. In the case reported by O'Leary and Burnett,[7] a string used for retrograde dilatation was drawn into the jejunum by a displaced broken gastrostomy flange, and peristaltic propulsion of the flange created a sawlike action of the string against the jejunum with resulting lacerations and perforations. A similar complication from excessive traction by the mercury-bag bolus must be considered a possibility.

Accidental rupture of the bag releasing the metallic mercury into the intestinal tract is an additional possible pitfall of mercury-bag passage. In our experience this has not occurred, probably because the mercury bag is retained in the intestinal tract for a relatively short time. With this potential complication in mind, observations have been made in several instances of rupture of the mercury bag of an intestinal decompression tube. No untoward effects have been noted. In general, the medical literature[2-4] attributes a harmless and nontoxic role to free metallic mercury within the intestinal tract. Birnbaum[8] reported a case of inflammation of the vermiform appendix by metallic mercury as noted at laparotomy for carcinoma of the rectum done a few days after the mercury-containing balloon of an intestinal decompression

tube had ruptured. Lindemuth[9] reported a fecal fistula which he considered to have been kept open by metallic mercury acting as a foreign body with granulomatous reaction. The fistula was at the drain site of appendectomy with perforation and peritonitis and the mercury had been spilled from the ruptured bag of an intestinal decompression tube. Yet Hoffman[10] reports the accidental swallowing of mercury by a child with temporary trapping in the appendix and later spontaneous evacuation without harm. And Cantor[11] reports on fecal fistulas which had excreted mercury lost from an improperly tied bag on an intestinal decompression tube. The fistulas in this patient closed when a defunctionizing colostomy was done, because no mercury was permanently trapped within the fistulous tracts to act there as a foreign body.

SUMMARY

The use of a mercury-bag bolus to expedite gastrointestinal passage of the swallowed esophageal dilator guide string is discussed. The contraindications and potential complications of the technique are suggested.

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ANTERIOR MEDIASTINAL TRACHEOTOMY

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IT IS inevitable that an aggressive surgical approach to mediastinal and low cervical disease should lead to an attempt to establish an airway elsewhere than in the cervical trachea. Methods for doing this have been discussed for about fifty years. Few actual cases, however, have been reported. Sloan and Cowley have recently described the successful establishment of a posterior mediastinal tracheotomy for the treatment of tracheal compression by a large aneurysm.[1] We should like to add to their report a case of recurrent, laryngeal carcinoma, obstructing the cervical tracheostomy, treated by the establishment of an anterior mediastinal tracheotomy.

CASE REPORT

A 43-year-old white man was first seen by a physician in March, 1949, at which time a laryngoscopy was done and a vocal cord biopsy obtained. This was reported to be a squamous-cell carcinoma, and laryngectomy was advised. The operation was refused by the patient and in April, 1949, a tracheotomy was established followed by roentgen therapy.

No more was heard from the patient until Feb. 9, 1950, when he applied for admission to the hospital for terminal care. On admission he was found to be breathing through a tracheotomy tube, and the larynx was found to be surrounded by a mass of inflammatory reaction. Intensive antibiotic therapy was instituted, and on March 10, 1950, a paralaryngeal abscess was incised and drained. This resulted in considerable improvement in the inflammation and much relief of symptoms. After the acute inflammatory symptoms had subsided, the patient's condition was re-evaluated, and it was decided that surgical extirpation of the larynx was the only procedure which could offer even a measure of palliation. The state of affairs was explained to the patient, and he consented to the heroic attempt at operation.

On March 16, 1950, a laryngectomy and thyroidectomy with resection of the cervical trachea were done. The thyroid gland was found to be inseparably fused to the larynx, and had to be sacrificed. The tumor itself had grown down the posterior wall of the trachea until it had reached the level of the tracheotomy, and, therefore, resection of the trachea to a point below the old tracheotomy was required. The histopathologic diagnoses of the surgical specimen were (1) squamous-cell carcinoma of larynx, intrinsic type with extension through the cartilage; (2) thyroiditis, acute, suppurative; (3) thyroid, showing evidence of radiation effect; and (4) tracheitis.

The postoperative course was uncomplicated. The wound healed and the patient was referred for instructions in laryngeal speech. There was a brief period, postoperatively, when large doses of vitamin D, calcium, and parathormone were required, but the symptoms of parathyroid deficiency subsided rather promptly. Symptoms of myxedema were controlled with oral thyroid extract. He was discharged on May 25, 1950, and contact was maintained by questionnaire. In June, 1951, approximately one year later, he was readmitted to the hospital with a recurrent tumor. The tumor was about 5 cm. in

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diameter and was located at the upper end of the tracheotomy, partially occluding it, so that a tracheotomy tube was necessary to maintain the airway (Fig. 1). After consultation with the radiologist, it was decided that radiation therapy was feasible if the metallic tracheotomy tube could, in some manner, be removed from the tumor site. It appeared that the best way to accomplish this was to make a new opening, anteriorly and low in the trachea. In anticipation of this procedure a 14 mm. polyethylene tube was obtained and molded to a suitable shape over a flame (Fig. 2).

Fig. 1.—Appearance of patient on admission. The large, recurrent carcinoma obstructs the tracheostomy to a degree which makes the constant wearing of the tracheotomy tube mandatory. Under these circumstances radiation therapy was felt to be impossible.

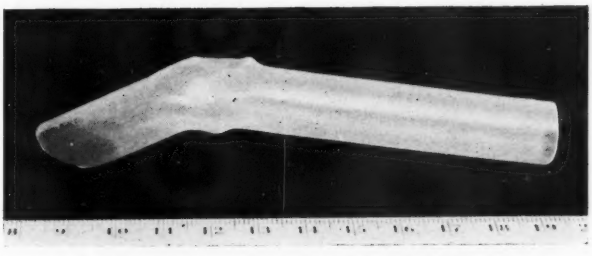

Fig. 2.—The type of polythene tubing used for the tracheotomy. The angle was created by manipulating the tube over a flame.

On July 27, 1951, the manubrium of the sternum was resected under intravenous pentothal and ether anesthesia. The trachea was opened longitudinally in the anterior midline, and the polyethylene tube was inserted just above the innominate artery. The skin edges were partially approximated (Fig. 3). Good aeration was obtained, but a change of the tube every other day was necessary because of the tendency for mucous plugs to obstruct its lumen. Several additional polyethylene tubes were prepared for this purpose so that a sterile tube was always available. After a period of adjustment the patient was able to change these tubes himself, to aspirate the trachea and, in general, care for the new tracheotomy as well as the old.

Intensive deep x-ray therapy was now given which resulted in a remarkable melting away of the recurrent tumor (Fig. 4). During this period the tumor degenerated into a necrotic slough which produced a considerable amount of foul-smelling drainage, much of which ran down into the trachea. Aspiration of the necrotic material would have been an insoluble nursing problem had not the patient been able to aspirate himself so easily. On Sept. 10, 1951, a razor graft was taken from the thigh and placed into the mediastinal defect to hasten epithelization. The slough finally disappeared, but an esophageal

Fig. 3.—Appearance of the patient shortly after resection of the manubrium and the establishment of an anterior mediastinal tracheotomy. This picture was taken just prior to the start of the radiation therapy.

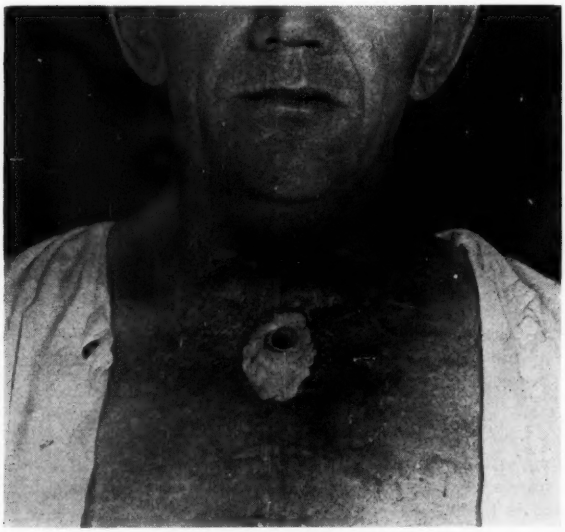

Fig. 4.—Postirradiation therapy appearance of the patient. Note the complete disappearance of the recurrent tumor in the neck. The preparation of skin flaps to line the sternal defect was delayed due to the radiation reaction in the skin.

stricture developed which required a Witzel gastrostomy (Oct. 5, 1951) to maintain nutrition. Four months after the anterior mediastinal tracheotomy was established the opening into the anterior mediastinum was largely epithelized, and the patient handled the new tracheotomy as readily as he did the old (Fig. 5). On Nov. 28, 1951, his unhappy life was terminated by a sudden gush of blood from the mediastinal tracheotomy. An autopsy was done, and it was discovered that the esophageal obstruction was due to involvement by recurrent tumor rather than radiation fibrosis. There also was a lymphangitic extension of tumor deep into the mediastinum and into the upper one-fourth of both lungs, as well as to the kidneys. Death was due to a linear perforation, about 5 mm. long, in the posterior wall of the innominate artery. Although polyethylene tubing is extremely light, an agent other than its pressure could not be postulated as the cause of the perforation.

Fig. 5.—Appearance of the anterior mediastinal tracheostomy with the gauze packing removed. Note that the defect is practically completely epithelized as a result of the razor graft.

DISCUSSION

The original plan of attack in this problem was to construct an anterior mediastinal tracheotomy, such as was done, and to line the defect with full thickness, pedicled skin grafts elevated from the chest, lateral to the tracheotomy, and rotated inward so as to form an epithelium-lined tract. This procedure would have formed a skin-lined permanent opening and would have protected the adjacent innominate artery. Unfortunately, our hand was forced by the extremely vigorous growth of the recurrence which could not be controlled by local cautery applications. It was not considered wise to attempt complicated plastic procedures in the face of imminent intensive radiation therapy and the procedure was, therefore, delayed until after the radiation effect in the skin had subsided. If such a skin-lined tube can be constructed, or an anterior mediastinal tracheotomy is planned for temporary use only, several important advantages over the posterior mediastinal tracheotomy are apparent. First, and most important, it is readily accessible to the patient who

is able to care for it himself with only the usual training. Second, it is not in the way, so that the patient can wear his usual clothing and can rest upon his back when he sleeps. Although this case had an unfortunate end result, it was due to difficulties imposed by his disease. The operation itself holds some hope for the establishment of an airway in cases where a cervical tracheotomy cannot be made.

SUMMARY

A case in which an anterior mediastinal tracheotomy was prepared is reported.

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CARCINOMA OF THE ESOPHAGUS COMPLICATING CARDIOSPASM

Report of a Case

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THE subject of cardiospasm or achalasia of the esophagus has received considerable attention in the surgical literature, but emphasis has been focused upon the various technical procedures recommended for its relief. Although the differential diagnosis between cardiospasm and carcinoma of the esophagus has been adequately stressed, there is a prevalent impression that once the diagnosis of the former has been established, the possibility of the latter need not be considered. In an article entitled "Surgical Considerations of Achalasia" published in 1940, Ochsner and DeBakey[1] gave a comprehensive review of the world literature with 121 references, and the possible coincidence of carcinoma and cardiospasm was not suggested. A very recent clinical article[2] described an experience with 1,800 cases of cardiospasm; there was no mention of malignancy as a complication.

Evidently, the combination of achalasia and carcinoma is rare. However, there are a number of well-authenticated cases, mostly reported in the radiologic literature. In 1933, Vinson and Kennedy[3] reported a case in which carcinoma developed seven years after the first hydrostatic dilatation. Kornblum and Fisher[4] reported two cases in 1940. One of these had carcinoma when first seen, and the other developed it ten years after symptomatic treatment by hydrostatic dilatation. In 1944, Bersack[5] presented the case of a 47-year-old man with a history of dysphagia for ten years, with a large fungating carcinoma of the mid-esophagus. In 1947, Baer and Sicher[6] were able to find only eight cases, including three of those mentioned above, which they would accept as genuine cases of carcinoma complicating achalasia, and added a case of their own. Because of the lack of clinical information, they did not include in their tabulation the three cases mentioned by Rake[7] in his early brief communication. Within a brief interval an additional example came under Sicher's[8] observation. It is of interest that only four of all the reported cases have been from the United States. Because of the rarity of the condition and some lessons which may be learned from the clinical history which terminated in the patient's death, the following case report is presented.

CASE REPORT

O. B., a white man, aged 42 years, was admitted to the emergency room of the Henry Ford Hospital on Oct. 30, 1950, with the complaint of vomiting bright red blood. Hematemesis of 5 or 6 cupfuls had occurred the day before and had been preceded by a tarry stool. He was dizzy and weak. A similar episode had occurred three years before. Considerable alcohol had been consumed for several years. The past history revealed

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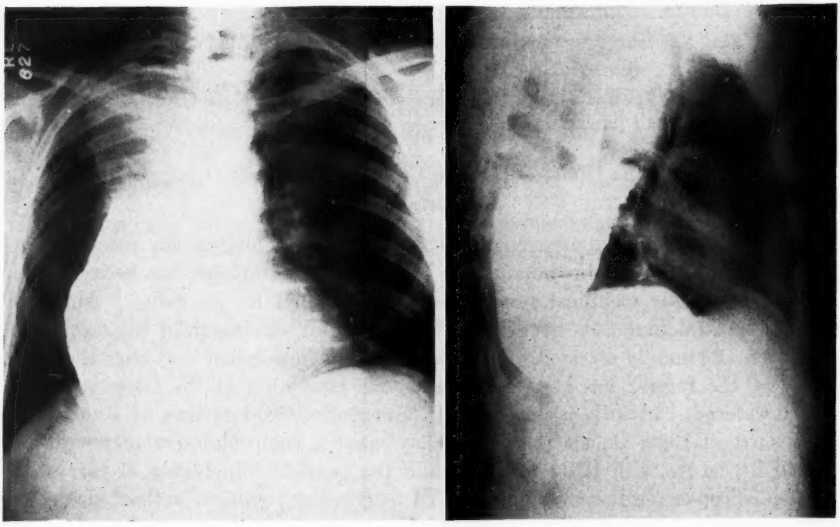

Fig. 1.—*A*, Antero-posterior roentgenogram of chest following the ingestion of barium showing markedly dilated esophagus lying principally in the right hemithorax. *B*, Lateral projection made at the same time. The irregularity of the anterior wall is probably significant.

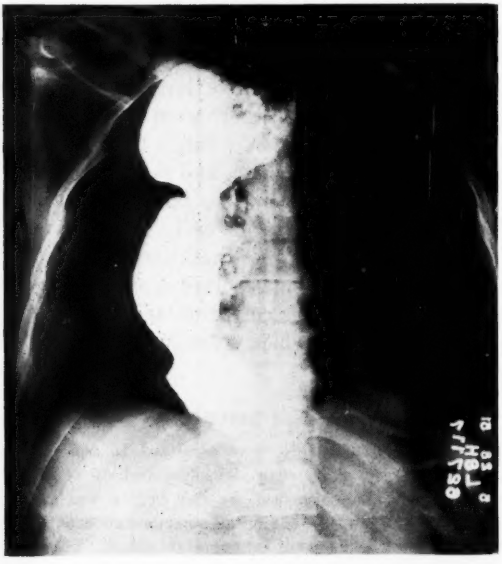

Fig. 2.—Esophagogram made seven months after that shown in Fig. 1. The filling defect in the mid-esophagus is easily evident.

gastrointestinal symptoms for more than ten years. These consisted of episodes of "vomiting," immediately or an hour after meals. The vomitus was never sour, hence it was assumed that the food had not reached the stomach. A radiologic examination in 1941 had demonstrated a greatly enlarged esophagus, but no treatment had been suggested. The provisional diagnoses were: bleeding peptic ulcer, bleeding esophageal varices, and cardiospasm with esophageal ulcer.

With cessation of bleeding, roentgen examination of the esophagus was carried out, and the following report was made: "Preliminary fluoroscopy of the chest revealed a large dense shadow extending half way into the right lung field and obscuring the right border of the cardiac shadow. As the patient was given barium, the shadow was realized to be the esophagus containing food and barium. The esophago-cardiac junction was poorly seen fluoroscopically and was visualized in only one of the films. There was much conical narrowing at the distal end of the esophagus with a markedly dilated, tortuous esophagus extending upward in the right chest to the level of the first rib. The stomach was partially filled. Impression: marked cardiospasm. The possibility of an ulcer at the distal end of the esophagus should be considered." (Fig. 1.)

Fig. 3.—Autopsy specimen showing bifurcation of the trachea with probes passed through the two bronchoesophageal fistulas. There is bullous emphysema of the right pulmonary apex.

There was rapid improvement on an ulcer dietary regime, and an immediate operation for cure of the cardiospasm was recommended. This advice was not accepted, and the patient left the hospital. He returned for one outpatient visit on Nov. 25, 1950, at which time he had gained in weight and strength. Chest distress was absent, and there had been no evidence of bleeding. Nevertheless, he was again urged to have radical surgical treatment for the achalasia.

He was next seen on May 4, 1951, at which time he complained of vomiting and dysphagia, and indicated his willingness to undergo an operation. He was admitted on May 27, but by this time there had been a weight loss of 30 pounds, and the "vomitus" again contained blood. Roentgenograms showed some changes in the shape of the esophagus (Fig. 2). At this time, he developed a persistent cough which was productive of grayish-yellow mucoid sputum. Tentatively, the pulmonary symptoms were believed to be the result of aspiration, but to settle this point bronchoscopy was carried out on June 18. "Granulation tissue" was seen posteriorly in both main bronchi and its removal was attended by lessened respiratory difficulty. Microscopically, the tissue removed from each of the bronchi proved to be squamous-cell carcinoma, Grade 2. It was evident at this time that we were dealing with inoperable cancer, and no effort was made to determine whether the lesion was primary in the esophagus or bronchi, although the involvement of both bronchi simultaneously suggested the former. Upon re-examination of the roentgenograms, it was realized that the filling defect in the first esophagogram showed a suspicious irregularity anteriorly.

Fig. 4.—Esophageal aspect of the lesion, showing the large carcinomatous ulcer in the anterior wall, extensive leukoplakic patches, and a smaller area of malignant change below the main lesion. The esophagogastric junction is well shown, and apparently the obstruction had been relieved by the palliative operation.

Palliative treatment by radiation was contemplated, and since by this time the patient could take virtually no food orally, a gastrostomy was also considered. Instead, at the insistence of the patient and his relatives, a cardiomyotomy of the Heller type was carried out. The procedure proved futile; a few days later the patient began to cough up all food which was swallowed, and it was evident that a large tracheo-esophageal fistula existed. The patient expired on July 11 after a brisk hemorrhage.

An autopsy (No. 5925) was performed two hours post mortem. There was incomplete union of the recent thoracic incision. The bronchi of both lungs were filled with blood-

stained mucopurulent material; the mucosal lining was thickened and hyperemic. A short distance distal to the carina on either side an irregular 3 mm. orifice was found opening on the posterior wall of each main bronchus (Fig. 3). These communicated directly with a bulky ulcerated neoplasm occupying the anterior wall of the midportion of the esophagus. The thoracic segment of the latter save for the terminal 2 cm. was enormously dilated to a circumference of 15 centimeters. A large irregular ulcerated tumor with elevated rolled edges occupied the segment immediately adjacent to the tracheal bifurcation (Fig. 4). The tumor except for the sloughing superficial portion was quite hard. Small vessels were apparent opening upon the irregular ulcer base, and these were considered the source of the hemorrhage which filled the stomach. A smaller satellite lesion of similar character lay 2 cm. distal to the primary growth. The remainder of the esophageal mucosa presented scattered patchy areas of thickening, roughening, and whitish discoloration regarded as leukoplakia. Inspection of the site of the cardiomyotomy showed that the constriction had been opened satisfactorily.

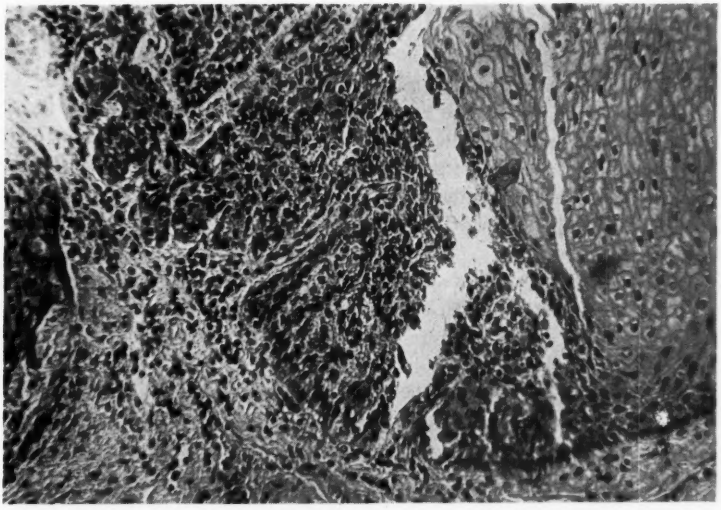

Fig. 5.—Photomicrograph showing the transition from normal esophageal mucosa (right) to carcinoma (left).

Microscopically, the lesion in the esophagus consisted of an ulcerated mass of wildly proliferating anaplastic epithelial cells (Fig. 5). The cells grew coherently, forming irregular anastomosing cords which penetrated the wall of the esophagus. The cells, despite their anaplasia, were distinctly squamous in character, and numerous pearls with keratinized cores were observed. The fistulous tracts leading to the bronchi were lined entirely by carcinomatous tissue, and tumor undergrew and elevated the respiratory mucosa surrounding each of the bronchial communications. Corresponding to the leukoplakia observed grossly, there were patchy areas of cornification of the mucosa.

Additional pathologic findings were: aspiration pneumonia, bullous emphysema of the right apex, and postoperative pleuritis of the left lower lobe.

DISCUSSION

It is obvious from a review of the case history that the presence of the complicating malignant lesion should have been strongly suspected when the patient was first seen with his second bout of hematemesis. Probably esophagoscopy

would have revealed the lesion. Assuming that carcinoma had been found in the anterior wall of the dilated esophagus at that time, an original plan of surgical treatment would have had to have been devised. Undoubtedly the conventional operation through the left chest with resection of the cardia and lower two-thirds of the esophagus and high esophagogastrostomy would have been technically impossible because of the marked dilatation of the esophagus, its dislocation into the right thorax and probable early attachment to the bifurcation of the trachea. Accessibility would have been difficult because of the arch of the aorta. One could have considered a two-stage procedure, the first operation being a Heller cardiomyoplasty, the second, a thoracotomy on the right with local excision of the carcinomatous ulcer and closure of the esophagus in continuity. The diameter of the huge esophagus would certainly have permitted this without any danger of stricture.

It is worth emphasizing that the symptom of dysphagia, the cardinal sign of carcinoma of the otherwise normal esophagus, is valueless in the diagnosis of malignancy in achalasia. First of all, some degree of dysphagia is already present, and second, in all the reported cases including our own, the cancer originated in the dilated middle third and obstruction had not been produced. In this connection, it should be pointed out that a number of standard pathology textbooks[9-11] state that carcinoma of the esophagus is more likely to occur at points of "physiologic narrowing." Such a tendency is certainly not evident in this group of cases.

Finally, one is tempted to speculate on the possibility that the development of cancer in the esophagus with cardiospasm may shed some light on the pathogenesis of this and other malignant lesions. The factor of chronic irritation with inflammatory changes and leukoplakia is certainly present. Also, there was a history of consumption of alcohol by our patient. This has been suggested as a possible predisposing factor, but statistically, no relationship has been demonstrated.[12, 13]

SUMMARY

A case of carcinoma of the esophagus complicating cardiospasm is added to the small number previously reported. The advisability of the more frequent use of the esophagoscope in inferred.

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SOME ASPECTS OF BRONCHIECTASIS IN INFANTS

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SINCE surprisingly little has been reported to date concerning the surgical treatment of bronchiectasis in the infant, we are presenting two cases which illustrate different etiologic factors and stress the feasibility of early surgical intervention.

CASE REPORTS

CASE 1.—Baby P. Q., aged 2½ months. This infant was first seen at the Buffalo Children's Hospital Aug. 17, 1950, when 2½ months of age. The presenting complaint was paroxysmal cough since one week of age. This symptom had become progressively more severe, and was accompanied with the production of tenacious mucus. Occasional emesis and cyanosis were noted following paroxysms of coughing.

On physical examination the child was well developed and well nourished. Attacks of coughing and considerable mucus in the pharynx were noted. There was dullness to percussion over the right lower chest accompanied by distant breath sounds and râles. A mild normocytic, hypochromic anemia was present. A tuberculin patch test in dilution of 1:1000 was negative, and tryptic activity was demonstrated in the stool.

A chest film showed a definite triangular density at the right base, with scattered areas of bronchopneumonia. Repeat roentgenographic studies revealed this abnormal density to be constant.

Treatment with antibiotics resulted in clinical improvement, and the infant was subsequently discharged. However, readmission was necessary within two months because the symptoms recurred. In the interim, signs of malnutrition and chronic illness had become evident. The previous density in the right chest on the roentgenogram remained unchanged (Fig. 1).

Bronchoscopy was performed and bronchograms were made. This contrast study revealed a definite saccular bronchiectasis in the right lower lobe (Fig. 2).

Pulmonary resection was decided upon, and the infant was transferred to the surgical division for preparation. In December, 1950, a right lower lobectomy was performed. The specimen exhibited diffuse, saccular bronchiectasis with purulent bronchitis (Fig. 3).

After an uneventful postoperative course, the infant was discharged on the tenth day. Roentgenographic examination of the chest at the time of discharge revealed the pulmonary fields to be clear (Fig. 4).

This patient illustrates the observations made by Wasson[1] in 1924. He found that aeration of the lower lobes was often incomplete for as long as two weeks after birth. In this infant the onset of pulmonary disease was established during the first week of life. It appears that the pathological bronchopulmonary changes occurred within two months. This rapid pathogenesis illustrates how quickly bronchiectasis may develop when superimposed on atelectasis.

Field[2] studied 272 cases of pulmonary collapse as to the possibility of bronchiectatic changes. She was able to demonstrate that of this group of cases, 115 had bronchial changes after re-expansion of the pulmonary tissue.

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CASE 2.—Infant J. D., aged 18 months. This patient was admitted to the Buffalo Children's Hospital with a history of recent exposure to tuberculosis. The symptoms, signs, and laboratory studies confirmed the diagnosis of tuberculous meningitis. Specific therapy was started.

Dullness to percussion and râles were present over the right lower chest at the time of admission. Roentgenographic examination of the chest revealed a right lower lobar pneumonia.

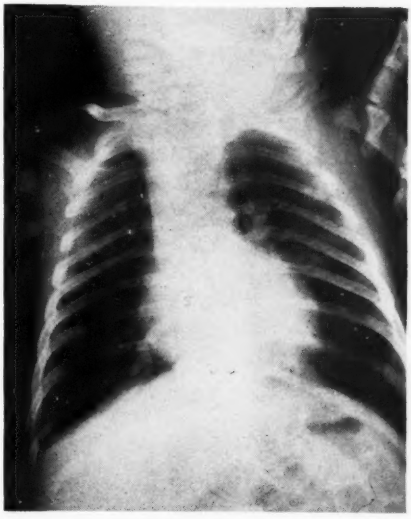

Fig. 1.—Admission chest roentgenogram showing triangular shadow at right base.

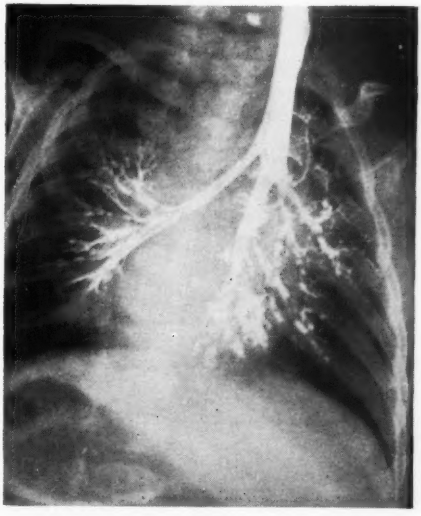

Fig. 2.—Bronchogram in oblique position. Note saccular dilatations of right lower lobe bronchi.

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After intensive therapy, the infant improved, and was discharged from the hospital after a ten months' stay. It was noted upon discharge that the pneumonic process had failed to resolve. Atelectasis with bronchiectasis was thought to be present in this area (Fig. 5).

In view of continuing clinical improvement, surgical resection of the involved portion of the lung was considered feasible. Roentgenographic studies, utilizing a contrast media, indicated bronchiectatic involvement of the right middle and lower lobes (Fig. 6). Following adequate preparation a right middle and lower lobectomy was done.

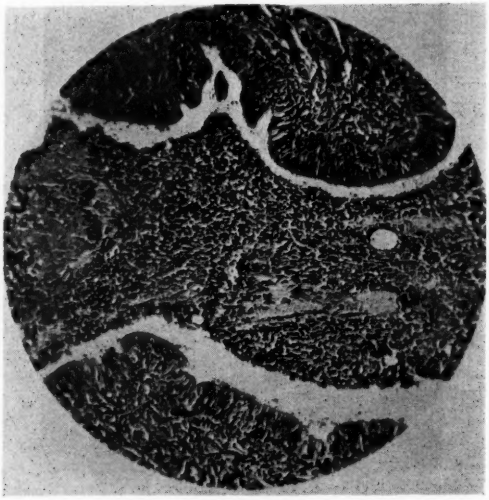

Fig. 3.—Low-power microphotograph. Lumen of bronchi filled with exudate. Note bronchiectatic changes with evidence of chronic inflammatory reaction.

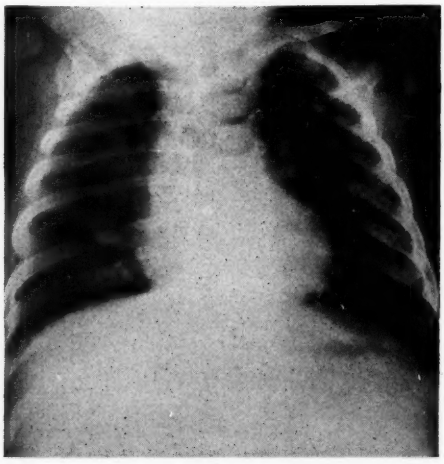

Fig. 4.—Chest roentgenogram taken at time of discharge from the hospital.

The pathologic specimen showed a diffuse cylindrical bronchiectasis. Atelectasis and interstitial infiltration with leukocytes were evident. Considerable fibrosis was noted surrounding the pulmonary arteries (Fig. 7).

No pulmonaary disease was evident at the time of discharge (Fig. 8).

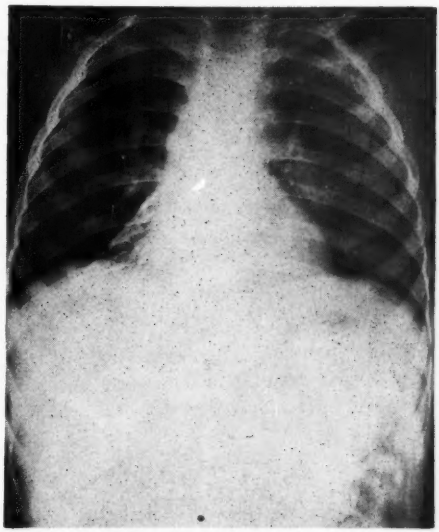

Fig. 5.—Chest plate taken at time of second admission. Note triangular basilar shadow on right.

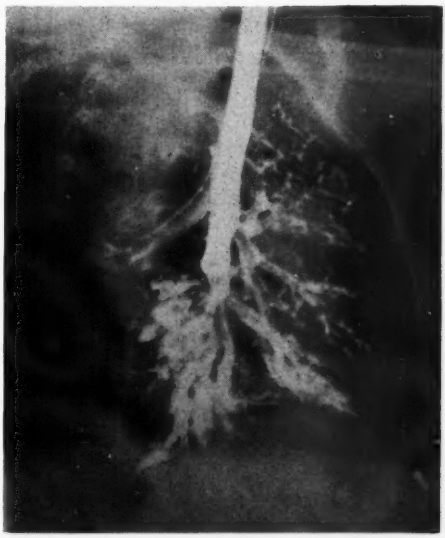

Fig. 6.—Bronchogram in oblique projection. Note extensive saccular dilatations of right lower bronchi and suggestive involvement of middle segment.

A discussion of the preceding case must consider the abnormal pulmonary physiology resulting from a severe and protracted illness. The pathogenesis seems to be one of partial bronchial occlusion and atelectasis superimposed on an infectious pneumonic process.

Nelson[3] is of the opinion that the bronchial obstruction and bronchial infection are basic mechanisms in the pathogenesis of bronchiectasis.

Fig. 7.—Low-power microphotograph. Note bronchial wall replaced with fibrous tissue. Evidence of chronic inflammatory changes and atelectasis.

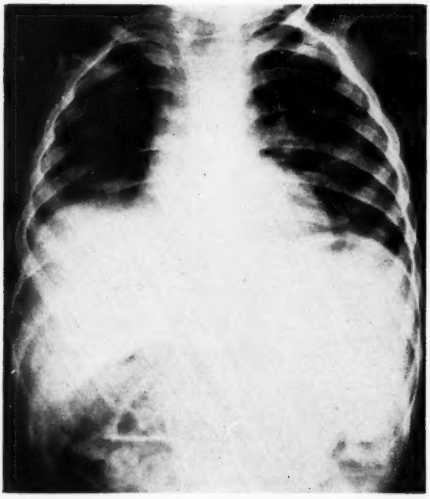

Fig. 8.—Chest roentgenogram taken at time of discharge from the hospital.

Pneumonia, along with other respiratory and exanthematous diseases, has been stressed as an important etiologic factor in the development of bronchiectasis. Field[4] studied 160 cases of bronchiectasis in children as to possible predisposing conditions. Pneumonia and other respiratory infections were listed as predisposing factors in 70 per cent of her cases. Although tuberculosis and syphilis are to be considered, these diseases are probably responsible for only a very small number of cases.

REVIEW OF THE LITERATURE

Bronchiectasis has been estimated to constitute about 5 per cent of all childhood diseases.[5] Sauerbruch[6] believed that in 80 per cent of the cases bronchiectasis could be traced to the early days of life. Bohrer[7] states that 50 per cent of adult patients date the onset of their disease to childhood. Perry and King[8] reviewed 400 cases of bronchiectasis. Their findings indicated that in 69 per cent of the series, bronchiectasis occurred before the twentieth year of life, and 42 per cent occurred before the tenth year of life.

The etiology of bronchiectasis remains controversial, and the presentation of a clear pathogenesis is often difficult. This bronchial disease has been categorically divided into congenital and acquired types. It may be said that, although many theories have been advocated, the true congenital form of the disease is rare and does not have a predilection for the lower lobes.[9] Engel[10] believed that a congenital weakness of the bronchial walls occasionally exists. This inherent weakness plus respiratory infection might produce the changes of bronchiectasis. Meyer's[11] study revealed bronchiectasis in siblings to be fourteen times more frequent than in the general population. Nelson's[3] group believed that the true congenital form of bronchiectasis and cystic disease of the lung were closely allied.

Acquired bronchiectasis has many varied etiologic factors. Exanthematous diseases, pertussis, respiratory infections, foreign body aspiration, sinusitis, and pneumonia have all been suspected. Atelectasis with associated bronchial infection seems to be the immediate causative factors.

The mortality and morbidity rates of bronchiectasis are high. In Table I are tabulated mortality figures of untreated bronchiectasis.

TABLE I

SOURCE OF INFORMATION	NUMBER OF CASES	MORTALITY (PER CENT)
1. Perry and King*[8]	400	26
2. Selby[12]	50	66
3. Roles and Todd[13]	49	46.9
4. Bradshaw, Putney & Clerf[14]	171	34.5

*A twelve-year follow-up study.

Lebert[13] analyzed fifty-two autopsied cases of bronchiectasis. Of this group, 21 per cent had died within the first year of the disease, and 75 per cent were dead within ten years of the onset of the disease.

Certainly, the above figures indicate that bronchiectasis has a high mortality rate within a short period of time.

Some years ago Brennemann[15] stated that the cure of bronchiectasis lay in the scope of early surgery. The argument would seem to be how safely can such procedures be carried out rather than whether surgery should or should not be done. The two cases we are reporting illustrate the feasibility of early operation in the infant. The case of Baby P. Q. appears to be the youngest age recorded in the literature for extirpation of bronchiectatic pulmonary tissue. Obviously, younger infants have been operated upon for congenital cystic pulmonary disease.

The surgical mortality rate in infants and children seems remarkably low as compared with the mortality rate of medically treated bronchiectasis.

Results in the surgical treatment of bronchiectasis in infants and children are shown in Table II.

TABLE II

SOURCE OF INFORMATION	NUMBER OF CASES OPERATED	MORTALITY (PER CENT)
1. Field[16]	50	2
2. Strieder[17]	25	0
3. Edwards[18]	38	0
4. Nelson[3]	25	0

Other authors (Riggens,[19] Buckles,[5] Field,[16] Bohrer[21]) point out the morbidity and occupational loss suffered by these patients. The inevitable picture of advanced bronchiectasis is one of chronic invalidism, mental lethargy, and social maladjustment.

Bohrer and Lester[20] predicated that such cases will be referred for surgical treatment more frequently as pediatricians realize the comparative safety of operative intervention. While no one denies bronchiectasis can be treated medically, such treatment requires endless, intelligent, methodical attention.

SUMMARY

Two infants developing bronchiectasis while under observation are described. In both, bronchial obstruction with infection was the apparent cause. In one infant the obstruction developed in connection with an unexpanded lower lobe. In the other, the obstruction was associated with the depression accompanying a tuberculous meningitis. Both were completely relieved of their pulmonary disease by operative extirpation.

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THYMIC NEOPLASMS

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INVESTIGATION of the literature pertaining to thymic neoplasms reveals disagreement and confusion. Perhaps much of this is due to the rarity of the lesion. Crosby[1] in 1932 reviewed all the cases of malignant thymic tumors up to that time and found only 166 cases. There have been, subsequently, approximately 100 additional cases on record. However, until recently[2] there has been no single large series reviewed and recorded by one group of observers. It becomes apparent that many of the reviews of the subject offered little more than the perpetuation of controversial and diversified opinions and observations.

Another source substantiating the lack of agreement regarding these tumors has been the varied opinions about the embryogenesis of the thymus gland and the exact identification of its cellular components. Clarification is, of course, necessary before a proper classification and understanding of these neoplasms can be obtained. It is the general consensus that the so-called thymocyte is, in truth, a lymphocyte, and that the so-called reticulum cell, or reticuloepithelial cell, is epithelial in nature arising from the entodermal epithelium of the third branchial cleft. These are the cells which form Hassall's corpuscles. Reference to these as reticulum cells appears unwarranted as well as confusing, since it bears no relationship, embryologically, to the reticulum cells observed in the tissues of the reticuloendothelial system. It becomes apparent, then, that primary neoplasms of the thymus gland would be either lymphoid, epithelial, or of a type demonstrating a combination of these elements. Although in Crosby's review[1] two-thirds of the neoplasms were considered as lymphosarcomas, nevertheless reference is made to the occurrence of epithelial elements tending to form structures similar to Hassall's corpuscles as a means of identifying the thymic origin of such neoplasms. Other reported instances of lymphosarcoma similarly mentioned the presence of epithelial cells in their microscopic descriptions. The lymphoid tumors as emphasized by Willis[3] and inferred by Seybold and associates[2] are exceedingly rare. Foot,[4] as well as Symmers,[5] also considers the mixed epithelial and lymphoid type the most common. With this rather simplified concept of thymic structure one is able to arrive at a rather practical classification. The following types are recognized: (1) lymphosarcoma, (2) carcinoma, (3) lymphoepithelioma (similar to the lymphoepitheliomas encountered in the upper respiratory tract), and (4) carcinoma; granulomatous type. The latter group has been well described by Lowenhaupt[6, 7] as representing tumors of immature thymic epithelial cells intermingled with a polymorphous in-

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flammatory infiltrate and a collagenous connective tissue stroma. The resultant picture is not unlike that of Hodgkin's granuloma, yet, if many areas of the tumor are studied, transitions to the more mature epithelial cell type and more familiar lymphoepithelioma pattern are recognized. This granulomatous variant is also recognized by Seybold and associates[2] as being epithelial in origin. Probably many of the reported instances of primary Hodgkin's disease of the thymus gland represent this diversification in thymic carcinoma; another variant described by Symmers, Helwig, and Foot is the perithelial type. However, since many of the neoplasms described in the other groups often demonstrate a perithelial pattern, the addition of this type to a classification of thymic neoplasms seems unnecessary. Although the rather noncommittal term of thymoma, first used by Grandhomme[8] in 1900, has been employed by many authors, confusion has been created because some investigators have chosen the term as referring to those neoplasms only of lymphoid structure, while others have used it with reference to the epithelial neoplasms of the thymus gland. With a more unified opinion as to the embryology of the thymus gland and an understanding of its cellular components, the term might well be discarded to avoid confusion and redundancy.

The segregation of tumors arising in mediastinal lymph nodes and adjacent pulmonary parenchyma may offer difficulty in the exact identification of some thymic tumors, especially since thymic neoplasms tend to invade contiguous structures by direct invasion. However, the vast majority of thymic neoplasms should be recognized, after careful histologic and roentgen study and gross anatomic investigation.

The association of thymic abnormalities with myasthenia gravis has also added a certain element of confusion to the subject of thymic tumors. One obtains the impression, from reports of Bell,[9] Lievre,[10] and Homburger,[11] that a distinct type of neoplasm is associated with myasthenia gravis. These investigators were of the opinion that the tumors were epithelial in type. However there are those[12, 13] who have contended that they are of a lymphoid nature and Norris[14] has stated that those instances of thymic abnormality associated with myasthenia gravis represent a hyperplasia. Seybold and coworkers[2] have, however, more recently demonstrated the similarity between the neoplasms associated with myasthenia and those tumors unaccompanied by this disease.

We shall report five instances of thymic neoplasm which tend to support many of the newer concepts and emphasize certain important clinical features of thymic tumors.

CASE 1.—A 27-year-old married white woman was admitted to the Cleveland Clinic Hospital because of thyroid enlargement. The patient had experienced weakness, anorexia, cough, and progressive weight loss for two months prior to admission.

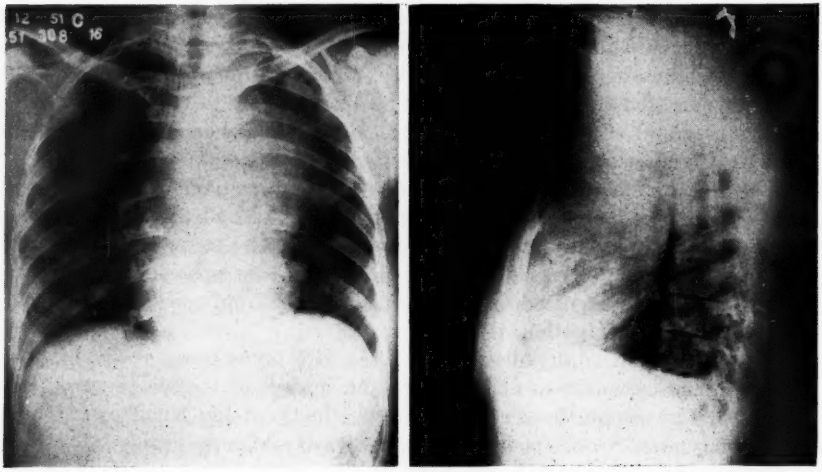
Physical examination revealed a rather well-developed, poorly nourished woman with pronounced pallor. Examination of the neck revealed the presence of a firm, nontender nodule overlying the superior pole of the right lobe of the thyroid. There was no cervical lymphadenopathy. There was limited expansion of the left side of the thoracic cage, and decreased breath sounds over the upper half of the left side of the chest posteriorly. A harsh systolic murmur was heard over the aortic area. The pulse was regular (72 per minute).

Blood pressure was 130/90. Abdominal examination revealed the presence of a large, firm, slightly tender mass in the right upper quadrant extending to the right flank. It did not appear to be continuous with the liver.

Laboratory examination revealed 3,900,000 red blood cells, hemoglobin 10.8 Gm., and a white blood count of 5,900, with normal differential. Urinalysis was negative, as were Kahn and Wassermann tests.

Roentgenograms (Fig. 1, *A* and *B*) of the chest demonstrated a large, soft tissue shadow extending from the left hilum superiorly and anteriorly. The mass had a smooth border and was somewhat lobulated. The right lung showed several soft tissue nodules in both the upper and lower lung fields. The heart appeared to be normal. Urography demonstrated inferior displacement of the right kidney with incomplete filling of the superior calyx. The opposite kidney was normal in configuration.

Hospital Course.—The thyroid nodule was removed for histologic examination.



A. *B.*

Fig. 1.—*A* and *B*, Anteroposterior and oblique roentgenograms of the chest, Case 1.

Microscopic Examination.—(Fig. 2.) Sections stained with hematoxylin, eosin, and methylene blue revealed a neoplasm replacing all but a few thyroid follicles. The neoplastic cells were polygonal, cuboidal, and round in shape with pink-staining cytoplasm, many of which were indefinite. The cell nuclei were for the most part vesicular, with moderate irregularity. An occasional mitotic figure was noted. The tumor cells were arranged in clusters which, in areas, showed a tendency toward whorl formation. An occasional lymphocyte was present among and between cell masses.

A Wilder's reticulum stain demonstrated a fine reticulum about some of the cell groups. However, there was no reticulum manifested about or between individual cells.

Diagnosis.—Carcinoma of thymic origin secondary in the thyroid. The patient was discharged from the hospital, and is currently receiving roentgen therapy on an outpatient basis.

CASE 2.—A 45-year-old white man entered the clinic with rather severe periodic cramping pain in the right flank. Sixteen years prior to this complaint, he had noticed difficulty in swallowing and some associated generalized numbness and weakness. This had progressed and on occasion had become severely incapacitating. A diagnosis of myasthenia gravis, after therapeutic tests, was made three years later. The patient stated that the use of prostigmine had given him exceptional relief. He remained well controlled with the use of several ampules

of prostigmine daily. About four years prior to his recent complaint he began to have bouts of postprandial diarrhea. With the onset of the diarrhea, the severity of the generalized weakness became minimized and his prostigmine requirement also decreased. The patient had lost 100 pounds during the last three years. At the time of admission he was taking one ampule of prostigmine which afforded relief from weakness for twenty-four hours.

Physical examination revealed a tall, somewhat emaciated white man in no apparent acute distress. Examination of the head and neck was negative, as was examination of the chest. Several small, discrete, posterior cervical lymph nodes were palpable. Blood pressure was 110/60. The liver, kidney, and spleen were not palpable. Slight tenderness was elicited on deep pressure over the right flank.

Laboratory studies showed hemoglobin of 13.5 Gm., and white blood count 13,750. Urinalysis, Wassermann, and Kahn tests were negative.

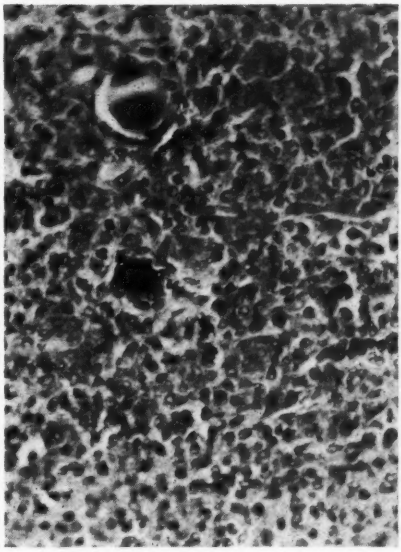


Fig. 2.—Thymic carcinoma in thyroid with few follicles remaining, principally epithelial. (×275.)

Roentgenogram of the chest revealed tracheal compression at the left of D4 and D5, with slight deviation to the left. There was narrowing of the trachea just below the sternal clavicular junction with no obstruction. A soft tissue mass to the right of the trachea at the level of the clavicle was noted. The left lung field was clear. Moderate pleural reaction was apparent over the upper right lung field with a soft tissue infiltration at the base. A number of circular areas, with increased density suggesting pleural and parenchymal metastatic lesions, were present on the right. Examination of the skeletal system was negative. Cholecystography and gastrointestinal roentgenograms, as well as an intravenous urogram, were negative.

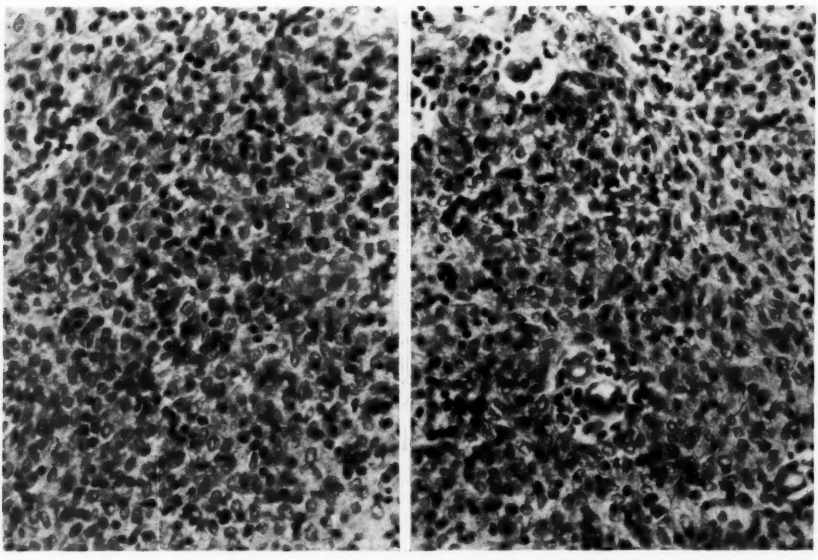
A thoracotomy was performed, at which time a large tumor mass was discovered extending from the anterior mediastinum to the adjacent right parietal pleura. Several tumor nodules were noted in the right lung and one was removed for histologic examination.

Microscopic Examination.—(Fig. 3, *A.*) Sections stained with hematoxylin, eosin, and methylene blue revealed a neoplasm formed by masses of cuboidal, and polygonal-shaped cells with indefinite pink-staining cytoplasms. The cell nuclei were irregular and for the most

part vesicular with occasional hyperchromasia, mitotic figures and a rare atypical mitosis. The tumor contained moderately dense connective tissue trabeculae. In areas there was whorling of the epithelial cells resembling Hassell's corpuscles. The epithelial elements appeared to lie in a stroma composed of mature lymphoyctes, some of which were intermingled with the epithelial components of the tumor. Approximately equal proportions of lymphoid and epithelial elements were present.

Sections treated with Wilder's reticulum stain revealed a moderately dense reticulum about cell groups.

Diagnosis.—Lymphoepithelioma of thymic origin in lung. The patient was given a course of nitrogen mustard therapy and discharged from the hospital. To date, one and one-half years after admission, his general condition has been satisfactory.



A. *B.*

Fig. 3.—*A*, Photomicrograph of neoplasm from Case 2. Patient had myasthenia gravis. (×275.) *B*, Section of neoplasm from Case 4. Patient did not have myasthenia. Identical histologically to 3, *A*. (×275.)

CASE 3.—The patient was a 58-year-old white man. For three months prior to admission he had noticed progressive weakness, slurring of speech, and difficulty in elevating his arms. He had also recently experienced difficulty in closing his jaws. All these symptoms were aggravated by any form of physical exertion, and appeared to become progressively worse throughout the day. An x-ray examination of his chest, taken two years prior to admission, had disclosed the presence of a mediastinal tumor.

Physical examination revealed a well-developed, well-nourished man with a thick, slurred speech which was barely intelligible. He showed considerable difficulty in elevating his arms. Examination of the head, neck, and chest was essentially negative. Blood pressure was 130/90. Examination of the abdomen was negative. The clinical diagnosis of myasthenia gravis was confirmed by the dramatic response to prostigmine.

Electrocardiographic studies were negative. Urinalysis was also negative. Hemoglobin was 14 Gm., and the white blood count was 7,500.

Roentgenogram of the chest demonstrated small, scattered calcifications in the left hilar region and left pulmonary parenchyma. There was a smooth, homogeneous mass in the right hilum and anterior mediastinum.

An anterior mediastinotomy was performed through a sternal splitting incision. An oval-shaped neoplasm situated in the anterior mediastinum overlying the aorta was encountered. The tumor measured approximately 5 by 3 by 2 cm. The neoplasm apparently was encapsulated and was rather easily removed in toto.

Pathology.—(Fig. 4, *A* and *B*.) The specimen consisted of an ovoid mass weighing 72 Gm. and measuring 4 by 3 by 2 cm. At one pole a conelike prolongation was evident. The outer surface was covered by a smooth, glistening, transparent, whitish-gray capsule. The cut surface revealed the main mass to be comprised of yellowish-gray, smooth, glistening tissue with interspersed, irregular areas of yellowish-gray necrosis. Section through the prolongation revealed yellowish-gray tissue with irregular areas of hemorrhage.

Fig. 4.—*A* and *B*, Outer and cut surfaces of neoplasm removed in Case 3.

Microscopic Examination.—Sections stained with hematoxylin, eosin, and methylene blue revealed a neoplasm comprised principally of mature lymphocytes. However, irregularly shaped, rather large, epithelial-like cells with pink-staining cytoplasms and irregular, somewhat vesicular nuclei were present among the lymphoid tissue arranged in small masses and clusters. An occasional mitotic figure was evident, as well as nuclear hyperchromasia. In areas a tendency to whorling was evident. Moderately dense bands of collagenous connective tissue trabeculae coursed throughout the tumor. A dense collagenous connective tissue capsule was apparent about all sections studied.

Diagnosis.—Lymphoepithelioma of the thymus. The postoperative course was uneventful and the symptoms of myasthenia gravis improved so that the patient no longer required prostigmine medication. The patient was well for approximately two and one-half years. However, a recent report (Fig. 5, *A* and *B*) has revealed that he has been confined to another hospital because of recurrence of the anterior mediastinal tumor as well as reappear-

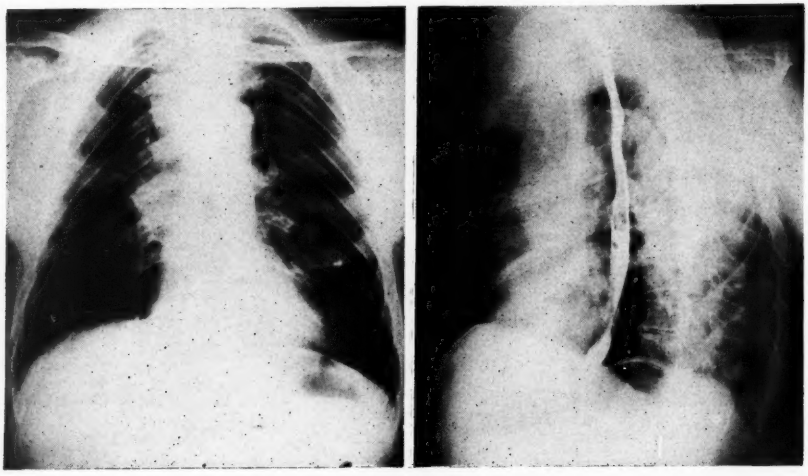
ance of the symptoms of myasthenia gravis, which now require prostigmine therapy. There are also symptoms indicating superior vena caval obstruction. The patient is receiving external x-ray therapy to the lesion.

CASE 4.—A 37-year-old white woman was admitted to the Cleveland Clinic for a routine physical examination. At the time she had no complaints. A routine examination, four years previously, revealed a normal roentgenogram of the chest.

Physical examination was essentially negative.

Laboratory studies revealed a red blood count of 5,100,000 cells, white blood count 15,675 with a normal differential, hemoglobin 12.5 Gm. Urinalysis was negative, as were blood Wassermann and Kahn tests. Stool examination revealed the presence of *Endameba histolytica.*

Chest roentgenogram demonstrated a large, rounded shadow projecting outward from the right mediastinal area. The mass had a diameter of 8.5 cm., and projected at least 4 cm. lateral to the right of the spine. Lateral films revealed that the mass was located in the anterior mediastinum. Roentgen examination of the gastrointestinal tract was negative. The patient refused thoracotomy at that time. However, several months later the patient was readmitted to the hospital because of shortness of breath and pain in the right side of the chest.



A. *B.*

Fig. 5.—*A* and *B*, Anteroposterior and oblique roentgenograms of recurrent neoplasm in Case 3.

Physical examination at the time of the second admission revealed a vigorous, healthy looking, well-developed, well-nourished, white woman in no apparent distress. Examination was essentially negative, except for moderate decrease in expansion of the right side of the chest with decreased breath sounds at the right base and flatness to percussion in the same area. The remainder of the examination was negative.

Exploratory thoracotomy was performed under endotracheal anesthesia. An inoperable anterior mediastinal tumor with extensive pleural metastases was discovered. Pleural implants were rather large, varying from to 6 cm. in cross diameter. The neoplasm also had invaded the right lung by direct extension. A biopsy was taken from one of the pleural implants.

Microscopic Examination.—(Figs. 3, *B* and 6.) Sections stained with hematoxylin, eosin and methylene blue revealed a neoplasm formed by two types of cells, each occurring in equal quantity. One cell type was mature lymphocytes; the other which demonstrated sheetlike and

cluster arrangements appeared epithelial. The epithelial cells were cuboidal and polygonal in shape although their cytoplasms were frequently indefinite. Nuclei were, for the most part, vesicular and irregular in shape. Nuclear borders were well defined. Occasional mitotic figures were frequent as well as a rare atypical form. Occasional nuclear hyperchromasia was also present. The epithelial masses were intermingled with the lymphocytes noted. A tumor thrombus comprised of both epithelial and lymphoid elements was present in a large endothelial lined space. Wilder's reticulum stain failed to reveal any reticulum associated with the neoplasm.

Diagnosis.—Lymphoepithelioma of thymic origin in pleura. Nitrogen mustard therapy was administered. The patient was discharged from the hospital three months ago.

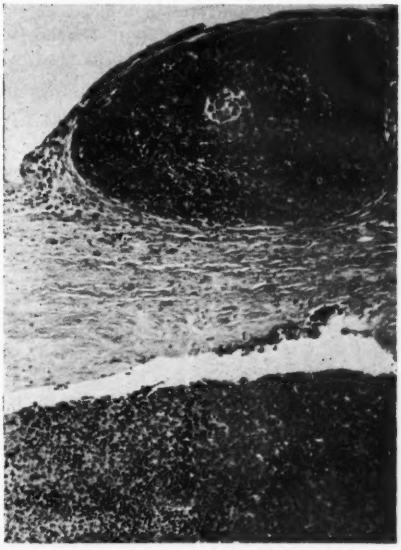


Fig. 6.—Tumor thrombus in endothelial lined space from neoplasm in Case 4. (×70.)

CASE 5.*—A 37-year-old white housewife presented herself for examination with the chief complaint of occasional epigastric distress and a sense of fullness in her neck. Roentgenogram of the chest one year prior to admission to the hospital was negative. There were no other complaints.

Physical check-up revealed a well-developed, thin, 37-year-old white woman in no acute distress. Head, neck, and lungs were normal. Blood pressure was 104/76; pulse was 96 per minute and regular. The remainder of the examination was noncontributory.

Laboratory Examination.—Erythrocyte count was 4.71 million, and hemoglobin 13.2 Gm. per cent; the white blood count was 8,400. Urinalysis was negative, as were Kahn and Wassermann tests.

Roentgenogram of the chest revealed a dense shadow in the anterior superior mediastinum.

A thoracotomy was performed, and a large portion of a lobulated, nonencapsulated mediastinal neoplasm was removed. It was noted that there was extreme extension into the upper portion of the left lung.

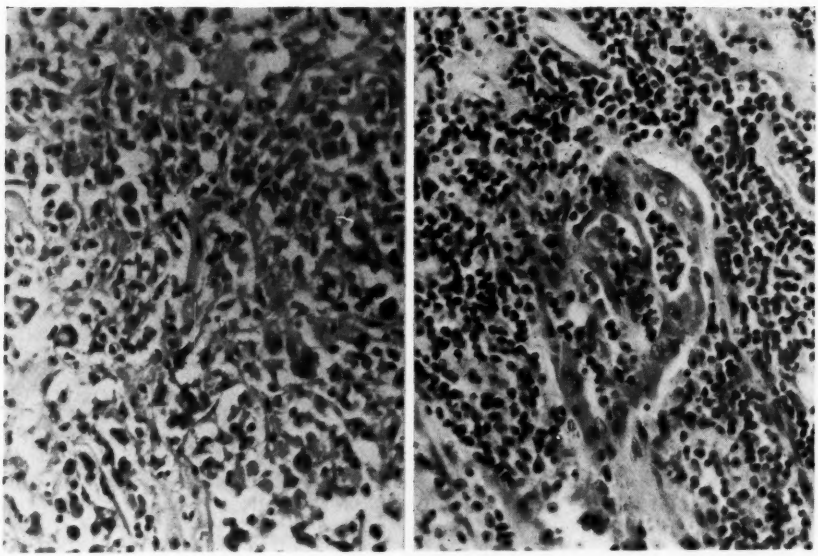
*This case was reviewed through the courtesy of Dr. Philip Graf and Dr. Earle B. Kay, Charity Hospital, Cleveland, Ohio.

Microscopic Examination.—(Fig. 7, *A*.) Sections of neoplasm removed from the mediastinum revealed a granulomatous-like lesion comprised of large, irregularly shaped epithelial-like cells, measuring approximately 40 microns in diameter. Cytoplasms of these cells were for the most part indefinite and pink staining. Nuclei were large, in many instances lobate or horseshoe-shaped with prominent nucleoli. These epithelial-like cells lay individually scattered among a polymorphous infiltrate comprised of lymphocytes, occasional neutrophils, and rare eosinophil. There was also a moderately dense, relatively acellular, collagenous connective tissue stroma with tendency toward trabeculation. In some areas there was pronounced necrosis.

Sections (Fig. 7, *B*) of neoplasm from the lung revealed masses of epithelial cells arranged in sheets and clusters somewhat similar to those noted in the mediastinal tumor. However, they were smaller and more uniform in appearance, with round nuclei. These epithelial masses lay in a stroma comprised principally of lymphocytes.

Diagnosis.—Carcinoma of thymus, granulomatous type.

The patient's postoperative course was uneventful, and she is now receiving roentgen therapy.



A. *B.*

Fig. 7.—*A*, Section of neoplasm in Case 5 from main mediastinal mass. Note granulomatous appearance with large atypical cells. (×275.) *B*, Section of neoplasm in lung from same case demonstrating more epithelial-like cells. (×275.)

DISCUSSION

Although none of the cases presented have been autopsied, nevertheless the histologic appearance of the neoplasms, as well as their roentgenographic and gross features at the time of thoracotomy, substantiates their thymic origin. They fulfill the identifying features of thymic neoplasms as stated by Jones.[15] These are: (1) large lobulated tumors at the site of the thymus, (2) extension

behind the sternum without infiltration of the bone, (3) involvement of the pericardium and pleura by direct extension, and (4) a resemblance to thymic tissue on histologic examination.

Histologically, the tumors are similar in that they contain both epithelial and lymphoid elements in varying proportions. The neoplasms from patients in Cases 2 and 4 demonstrated equal lymphoid and epithelial components, whereas the tumor in Case 3 was predominately lymphocytic, and that in Case 1 predominately epithelial. The neoplasm classified as carcinoma, granulomatous type, resembled those tumors recently described by Lowenhaupt.[6, 7] Although they present a microscopic picture not unlike that of Hodgkin's disease, their true epithelial nature has been well explained by indicating their resemblance to immature thymic epithelium. The interpretation of the histologic appearances of the five tumors studied resembles the more recent concepts of the structure of thymic neoplasms.

A perplexing question for the pathologist to answer is whether a given thymic neoplasm is benign or malignant. Certainly this distinction cannot be made from histologic study alone, as evident from the study of the neoplasms reported here or the much larger series of Seybold and associates.[2] All of the neoplasms studied demonstrated some nuclear hyperchromasia, irregularity, and pleomorphism, as well as an occasional pathologic mitosis in one. Further, these tumors show a definite tendency toward invasion of contiguous structures, and the occurrence of distant metastases in a large proportion of cases, as indicated by Crosby[1] and Willis,[3] makes it apparent that all thymic neoplasms must be regarded with extreme suspicion. Even with apparent encapsulation and complete removal, as in our Case 3, recurrence occurred two years subsequent to surgery. This further emphasizes the necessity for caution in the prognosis of thymic tumors.

As has been previously mentioned, there are no histologic criteria which enable one to differentiate the thymic neoplasm associated with myasthenia gravis from those tumors unassociated with this disease. The concept that malignant thymic tumors are not associated with myasthenia gravis must be altered. Derow and co-workers[16] have stated that approximately 10 per cent of thymic neoplasms associated with myasthenia gravis encroach upon contiguous structures, and they have reported a case with intrapulmonary metastases. Our Case 2 is quite similar, in that pulmonary metastases were also present.

It is interesting to note that in this small group of thymic neoplasms only one presented symptoms indicating mediastinal obstruction, the classical symptoms associated with these tumors. In one, the first clinical manifestation was the presence of a metastatic nodule in the thyroid. One was discovered during a routine roentgen examination of the chest. This latter patient had numerous pleural implants at the time of thoracotomy, yet had no symptoms at the time the lesion was first discovered. Two of the tumors were associated with myasthenia gravis. It has been estimated that 75 per cent of the patients with thymic tumor have myasthenia gravis, whereas 50 per cent of the patients

with myasthenia gravis will also demonstrate an associated thymic tumor.[2]

The cases of thymic tumor associated with myasthenia gravis are unusual from a clinical standpoint. One patient, Case 2, experienced definite relief from the symptoms of myasthenia gravis which had been present for thirteen years with the apparent onset of the thymic neoplasm, and his prostigmine requirements were reduced suggesting that a prostigmine-like substance was being elaborated by the neoplasm. This effect was also manifested by the occurrence of intestinal hypermotility. Microscopic study of the neoplasm offered no explanation for such behavior since it resembled other tumors in the group. Although pharmacologic studies of these tumors have been attempted, their results have been discouraging. No similar case of thymic neoplasm and myasthenia gravis has been reported in the literature. The other patient with the thymic tumor and myasthenia gravis experienced relief from his myasthenia following the removal of a thymic neoplasm. Exacerbation, however, occurred with recurrence of the tumor. These unusual features as well as those in the patient described by Fehrshtand and Shaw[17] (in whom the symptoms of myasthenia developed after the removal of a thymic tumor) demonstrate not only the unpredictability of the clinical course in patients with myasthenia gravis and thymic tumors, but also our inadequate interpretation of their relationship.

The cases reported have not been followed for sufficient periods to allow for the evaluation of therapy. However, it might be stated that the use of nitrogen mustard therapy or x-ray therapy has been disappointing. This has been the experience of others who have reported on longer follow-up periods on this type of treatment. It appears that, when possible, the treatment of choice is surgical excision of the neoplasm. Seybold and associates[2] have observed no recurrences in their group treated in this manner.

SUMMARY

The literature pertaining to thymic neoplasms is reviewed, with an attempt toward presenting a simplified understanding of terminology, embryology and classification of these neoplasms.

Thymic tumors may be classified into: (1) lymphosarcoma; (2) carcinoma; (3) lymphoepithelioma, and (4) carcinoma, granulomatous type.

Five cases of thymic tumor are reported. One of the patients with myasthenia gravis studied demonstrated pronounced diminution in the symptoms and prostigmine requirements of a pre-existing myasthenia gravis with the apparent development of a thymic tumor, suggesting that a prostigmine-like substance was elaborated by the neoplasm.

The frequent occurrence of invasion of adjacent structures, as well as the occurrence of distant metastases and lack of histologic difference between so-called benign and malignant thymic neoplasms, indicates that all such tumors must be regarded with suspicion. The recurrence of a tumor which had been apparently encapsulated and completely removed two years after operation (Case 3) emphasizes the caution necessary in prognosticating the clinical behavior of these neoplasms.

There is no histologic criteria by which the thymic tumors associated with myasthenia gravis can be differentiated from those unaccompanied by this disease.

Thymic tumors unassociated with myasthenia gravis may be asymptomatic. Only one of the three patients without myasthenia gravis presented the more classical symptoms of thymic tumor.

It appears that surgical extirpation is the treatment of choice although many cases on initial observation are inoperable. Nitrogen mustard therapy, or x-ray therapy, has been for the most part disappointing in the inoperable cases.

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INDICATIONS FOR A DELAYED ROENTGENOGRAM IN BRONCHOGRAPHY

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IN MAPPING out the extent of surgical resection for a patient with bronchiectasis, a delayed film following bronchography may prove to be of considerable value. Often important in establishing the presence of bronchiectasis, such a delayed film may also help avoid needless sacrifice of tissue by eliminating uncertainty concerning a specific bronchial segment. Lung tissue may thus be conserved without the risk of compromising a complete cure.

Three cases have been selected to demonstrate the value of a delayed roentgenogram in bronchography.

CASE 1.—Bronchography was performed for preoperative localization of bronchiectasis. Definite dilatation of bronchi was disclosed in the right middle lobe (Fig. 1, *A*). There also appeared to be obstruction and some cylindrical enlargement of an adjacent bronchus in the anterior segment of the right upper lobe (arrow). In the delayed film (Fig. 1, *B*) obstruction to the latter bronchus is seen to have been overcome. Return of the bronchial caliber to normal with filling of its peripheral branches excluded any need for removal of this lung segment (arrow).

CASE 2.—Bronchography was performed in this patient to determine the status of the bronchial tree. Extensive saccular and cylindrical changes were demonstrated in the left upper-lobe bronchi (Fig. 2, *A*). A suggestion of cylindrical bronchiectasis was also noted in the lower lobe. The lateral film (Fig. 2, *B*), taken after some delay, disclosed these lower bronchi to be of normal caliber except for a peripheral branch of the posterior basal segment.

CASE 3.—Bronchography was undertaken because of clinical suspicion of bronchiectasis. The immediate film (Fig. 3, *A*) revealed incomplete filling of the left lower-lobe bronchi without significant alteration in their proximal portions. By allowing further gravitation of iodized oil into the basal segments, the delayed film (Fig. 3, *B*) disclosed both saccular and cylindrical bronchiectases, which might otherwise have been overlooked.

DISCUSSION

Although techniques for bronchography have been discussed in numerous articles,[1, 6, 7] no direct reference has been made to the indications for a delayed roentgenogram. Only Farinas[4] recognized the value of additional films in the serial study of bronchial filling for inflammatory and neoplastic lung changes.

Assuming a satisfactory technique for instillation and distribution of contrast media through the various segments of the bronchial tree, there are four factors which influence filling of the peripheral bronchi.

1. *Physical Nature of Contrast Substance.*—Both oil- and water-soluble contrast media are now available for bronchography. The oils have been in use since bronchography was originated by Forestier in 1921. Only recently have satisfactory water-soluble substances been reported.[2, 3, 5] It appears that

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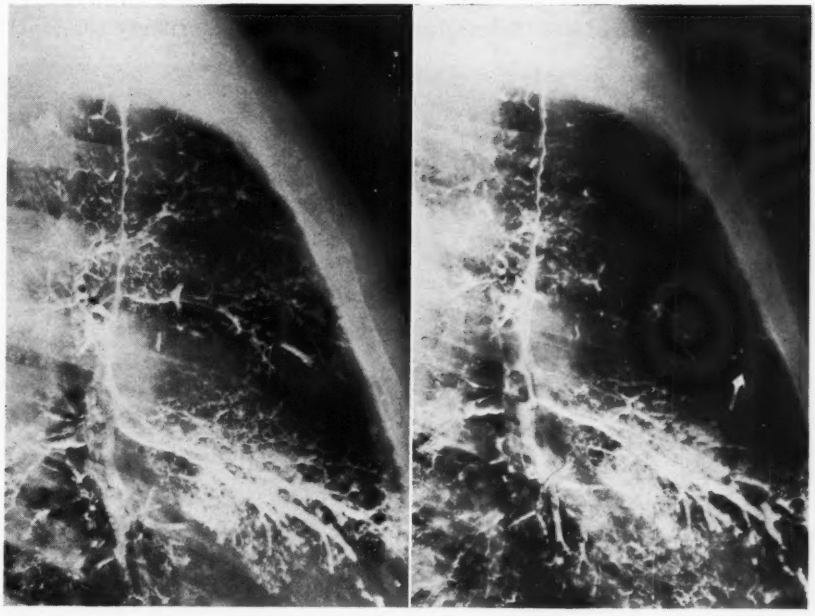
some of the disadvantages of the oil media may be overcome by agents such as Ioduran B. However, the slow elimination of iodized oil allows for delayed studies of those areas which may initially show incomplete filling. Aqueous substances, being rapidly absorbed or easily drained, do not lend themselves to such studies. Our references to the delayed roentgenogram in bronchography, therefore, assume the use of iodized oils, such as Lipiodol or Iodochlorol.



A. *B.*

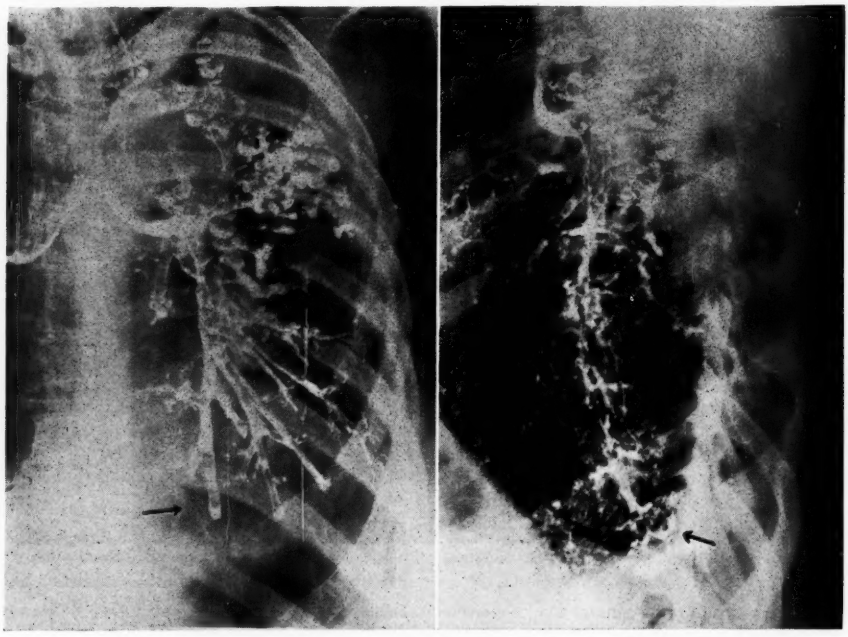
Fig. 1.—*A*, Immediate film following bronchography. Right lateral view disclosing bronchiectasis in the right middle lobe. In addition, the arrow indicates obstructed and dilated bronchus in the anterior segment of the right upper lobe. *B*, Delayed film following bronchography. Similar film taken a few minutes later indicates obstruction of the bronchus in the right upper lobe to have been due to transient air block. The oil is seen to have penetrated to the periphery of this branch, its caliber having returned to normal.

2. *Volume of Contrast Substance Used.*—The influence of this factor on filling of the peripheral bronchi is an obvious one. The presence of an excess of iodized oil in the proximal bronchus excludes the question of inadequate contrast substance as a cause of incomplete visualization.

3. *Temperature of Contrast Media.*—Reducing the viscosity of iodized oil by heating increases its speed of flow and its ability to enter stenosed bronchi. However, such changes in viscosity favor alveolar filling and make satisfactory distribution of the oil more difficult. Affecting reduction in viscosity of Lipiodol by dilution with a pure vegetable oil has the added disadvantage of decreasing its radiographic density. A short interval between the immediate and delayed

film allows the body tissues to affect warming of the oil with some reduction in its viscosity and favors gravitation into the peripheral bronchi, unless they are completely obstructed.

4. *Patency of the Bronchi.*—If we assume satisfactory control of the above factors, patency then remains the most important determinant in outlining the bronchi of any lung segment. Retained secretions, material trapped by stricture or by kinking of a bronchus and air blocked locally by the inflow of contrast substance, may each impose considerable, though transient delay in the passage of iodized oil. Incomplete information or uncertainty concerning



A. *B.*

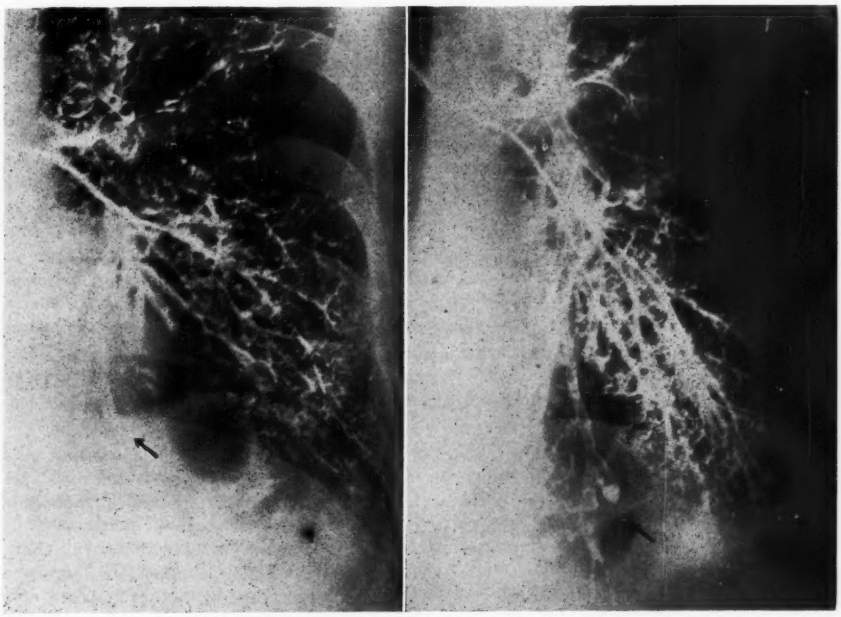
Fig. 2.—*A*, Immediate film following bronchography. In addition to obvious saccular and cylindrical bronchiectases in the left upper lobe, the bronchi in the lower lobe appeared to be obstructed and dilated. *B*, Delayed lateral film following bronchography. Left lateral view disclosed the bronchi of the lower lobe to be of normal caliber, except for a peripheral branch of the posterior basal segment. The appearance of the immediate film was apparently due to transient air block of the bronchi.

individual bronchi may result from such interference with their patency. The delayed film following bronchography helps to eliminate such transient sources of confusion.

A delayed roentgenogram is indicated when examination of the wet film taken immediately following bronchography discloses adequate contrast substance in a proximal bronchus, associated with failure to outline its peripheral branches. In the interval before taking such an additional film, the patient should be maintained, for about five minutes, in a position favoring gravitation

of the contrast substance into the unfilled segments. In the latter position he should be instructed to breathe very slowly and deeply, encouraging maximum dilatation and elongation of bronchi as a further aid to entrance of the iodized oil.

It may be seen from the accompanying illustrations (Figs. 1, 2, and 3) that the delayed film following bronchography has proved of definite value by serving the following purposes: (a) avoiding the need for additional instillations of iodized oil or repeated bronchography due to incomplete filling of peripheral bronchi and (b) eliminating transient hydrostatic bronchial



A. *B.*

Fig. 3.—*A*, Immediate film following bronchography. Lower-lobe bronchi are seen through the shadow of the left ventricle. These appear obstructed, the one indicated by the arrow being suggestive of minimal cylindrical ectasia. *B*, Delayed film following bronchography. A few minutes later, the bronchus which appeared slightly dilated was seen to be of normal caliber. The more lateral bronchus visualized incompletely on the immediate film clearly shows cylindrical dilatation which might otherwise have escaped detection.

dilatations which might be mistaken for minimal bronchiectasis and needlessly included in resectional lung surgery or subsequently classified as "reversible."

The immediate roentgenogram following bronchial instillation of iodized oil remains essential to a clear demonstration of mucosal pattern, bronchial distribution and the interrelation of bronchi. Delayed roentgenograms following bronchography are, therefore, not intended to replace but rather to supplement the immediate films. The delayed roentgenogram will not obviate the need for expectorants, antispasmodics, postural drainage or bronchoscopy when these appear indicated as preliminaries to bronchography.

SUMMARY

The purpose and indications for a delayed roentgenogram following bronchography are outlined. Bronchograms are presented from three illustrative cases. Factors relevant to the subject of bronchial visualization are reviewed.

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ATRESIA OF CERVICAL ESOPHAGUS

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ATRESIA of the cervical esophagus from a fibromuscular stenosis of the cricopharyngeus muscle is extremely rare. The simple and effective method of the relief of the atresia makes this case worthy of reporting.

CASE REPORT

E. R., 51-8366, a 12-year-old schoolgirl, was admitted for the third time to St. Mary's Hospital complaining of difficulty in swallowing for eight years. She was able to swallow liquids only in the past three years, and during the past year she would require twenty to thirty minutes to drink half a glass of water. Her swallowing was unchanged by emotions, fatigue, or diet. There was no associated coughing, choking, or dyspnea.

Past history revealed a tonsillectomy at the age of 3 years, and fever of unknown cause six months later. Hesitancy in swallowing was noted about one year after tonsillectomy. Poor dental hygiene was noted, with extraction of upper incisors one year ago. No menses had occurred. The patient was about thirty pounds underweight.

Physical Examination.—Temperature 98.8° F., pulse 84, respirations 22, body weight 39 pounds. The patient was malnourished and small of stature. Her head was well formed, upper incisors missing, tonsils absent; pharynx showed healed tonsillar fossa. Chest was symmetrical; no râles; heart tones were clear. Abdomen was soft; normal female genitalia; extremities symmetrical; reflex physiological.

Laboratory Data.—Hemoglobin 10.9 Gm.; red blood cells 4,060,000; white blood cells 12,890; urinalysis negative; Wassermann negative. Chest roentgenogram revealed no pneumonitis; esophagram revealed atresia at cricopharyngeal region (Figs. 1 and 2).

Hospital Course.—Pharyngoscopy showed a stenosis at the pharyngeo-esophageal junction that would barely admit a No. 16 dilator. The mucosa was intact and normal. The left pyriform sinus was distorted in contrast to the opposite structure. The larynx was normal.

A Stamm gastrostomy was performed for feeding purposes and also for the retrograde introduction of radioopaque material in the lower esophagus. The study showed a normal esophagus up to the cricopharyngeus. No radiopaque material passed above this area. The patient was placed on a balanced gastrostomy feeding totaling nearly 2,200 calories a day. The patient remained at home for several weeks, and gained six pounds.

Upon readmission she appeared markedly improved in nourishment and growth. She received penicillin lozenges four times a day, and oral hygiene twice a day.

An exploration of the cervical esophagus was performed under gas-oxygen-ether anesthesia with an intratracheal catheter. A left-sided semi-collor incision was made, and the trachea and larynx mobilized. The left recurrent laryngeal nerve was retracted and the left inferior thyroid artery to the esophagus was divided so that the entire cervical esophagus and the lower third of the pharynx were exposed. The pharyngeus muscles joined together to form a sphincter at the cricopharyngeus. The sphincterlike muscle was approximately 5 by 9 mm. thick, and the esophageal lumen was narrowed to 4 mm. It was well formed and rather firm in consistency. The sphincterlike band was easily freed from the subjacent longitudinal muscle fibers. An incision was made through the band with an immediate relaxation of the atresia area. A sensation of cutting fibrous tissue was experienced. Another incision was made through the band in the posterior

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Fig. 1.—Posteroanterior esophagram. Barium failed to pass into the esophagus. Pharynx outlined.

Fig. 2.—Lateral esophagram showing barium outlining pharynx. Esophagus occluded at the cricopharynegeal region.

portion. Thereafter the anesthetist was able to readily pass a No. 20F catheter. A portion of the sphincterlike band was excised for microscopic study. Slight separation of the longitudinal muscle elements exposed the mucosa which was intact and apparently normal. The cervical incision was closed in layers after placing a Penrose drain to the lowest part. An all silk technique was used throughout (Fig. 3).

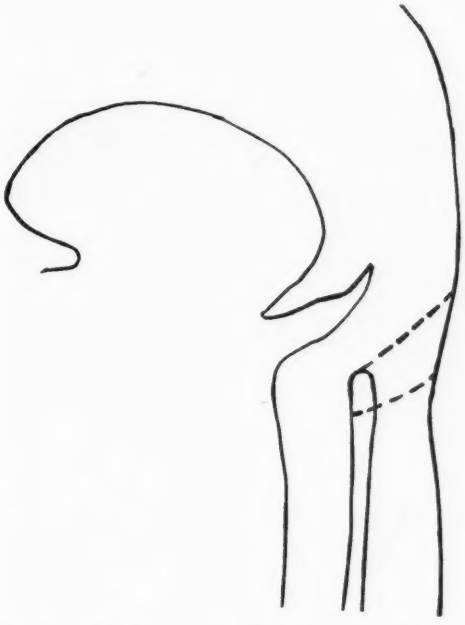

Fig. 3.—Schematic outline of pharynx. Dotted line indicates cricopharyngeal band.

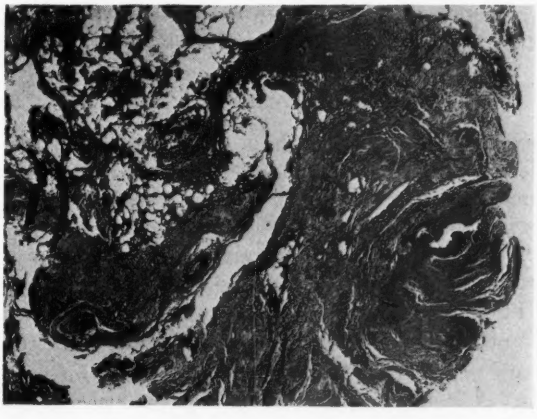

Fig. 4.—Low-power photomicrograph of the fibromuscular band.

The microscopic examination of the resected sphincterlike muscle band showed "normal striated muscle fibers. The blood vessels appear normal. There is no dense scar tissue. Scattered areas of fibrosis can be seen between muscle fasciculus" (Fig. 4).

Her convalescence was uneventful. There was a slight huskiness of her voice the first day, and on her third postoperative day she was ambulatory and beginning to take solid foods. She was discharged after gaining sixteen pounds.

A year later the patient had gained another twenty pounds. Fluoroscopic observation of a barium swallow failed to show any hesitancy. She states that she can eat all kinds of food rapidly and without distress (Fig. 5).

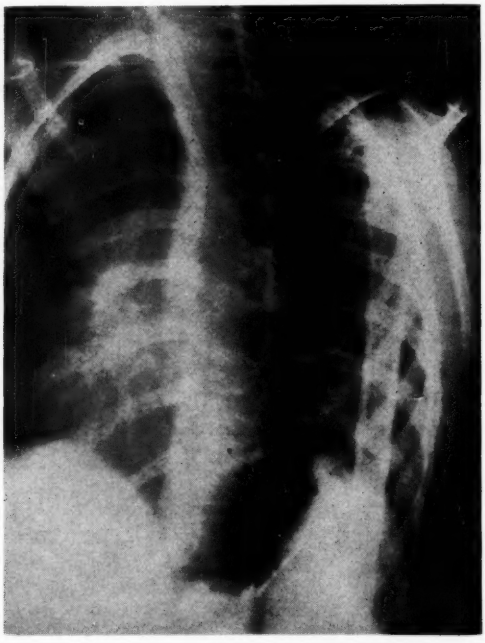

Fig. 5.—Postoperative esophagram. Barium passed readily into thoracic esophagus. Slight indentation in cricopharyngeal area but no obstruction.

COMMENT

The etiology of the stenosis may be a congenital atresia of the esophagus or a posttonsillectomy retropharyngeal abscess. The atresia is suggested by the intact and normal mucosa and the lack of paraesophageal fibrosa. Some difficulty in swallowing could have been present earlier but missed because of the young age of the patient. The clinical course, however, favors a low-grade infection of the retropharyngeal area following a tonsillectomy with the development of fibrosis in the pharyngeus muscle and contraction of the cricopharyngeus muscle. The distortion of the left pyriform sinus would favor this view.

A preliminary gastrostomy was considered essential for improving the patient's nutrition. A more essential purpose was the attempt to determine the possibility of additional contractures in the lower portion of the esophagus.

Multiple strictures of the esophagus would cause one to favor resection with esophageal or esophagogastric anastomosis. A localized contraction would suggest a segmental resection of the esophagus with a direct anastomosis or the substitution of a skin-lined tube as in the Wookey procedure. The employment of the Heller procedure was strongly favored when it appeared that the mucosa was normal and intact. Heller's operation for cardiospasm of the lower esophagus was modified by freeing the sphincterlike band and resecting a portion. The procedure corrected the atresia effectively as evidenced by the bulging longitudinal muscle fibers through the created defect.

SUMMARY

A rare case of cricopharyngeal atresia is presented, with a simple highly effective corrective procedure.

EFFECTS OF INCREASED ENDOBRONCHIAL PRESSURE, VITAMIN A DEFICIENT DIETS, AND NASOPHARYNGEAL INSTALLATIONS OF BACTERIA ON THE TRACHEOBRONCHIAL TREES OF YOUNG RATS

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THE many theories regarding the causes of bronchiectasis have been capably reviewed by Andrus,[1] by Adams and Escudero,[2] Lisa and Rosenblatt,[3] and by Mallory.[4] Much experimental work has been done on the production of bronchiectasis, and the investigations and reviews of Weinberg,[5] of Adams and Escudero,[2] and of Tannenberg and Pinner[6] are outstanding. The effects on the respiratory tract of complete and partial bronchial obstruction, atelectasis, infection, and variations in intrathoracic pressure have been studied by many workers.

In discussing case histories of patients with "idiopathic" bronchiectasis, clinicians have frequently commented on the following observations: (1) the onset of symptoms in the early years of life, as shown by Perry and King,[7] 42 per cent of whose patients had the onset in the first decade of life, with 69 per cent of the patients developing the disease before the age of 20 years; (2) the frequency of the onset of symptoms of bronchiectasis following bronchopneumonia—pertussis and other respiratory infections have been discussed by Field[8]; and (3) the same author has described the poor nutritional status of most of the patients with bronchiectasis.

It is of interest to note the two factors which are common to this condition, chronic cough and malnutrition, and to consider the possible relationship which such factors might have to the development of bronchiectasis.

Cough as a bronchodilating factor consists of two components: (a) the increased endobronchial pressure during the compressive phase of coughing immediately preceding the expulsive phase, and (b) the deep inspirations immediately preceding and following a cough. The physical factors active in coughing, and the various opinions regarding its relationship to bronchiectasis have been reviewed by Andrus.[1]

Malnutrition may have two important sequelae, particularly in patients with bronchiectasis: (a) general decrease in resistance to infection, and (b) the specific effect on tracheobronchial epithelium resulting from inadequate vitamin A intake or utilization. This latter effect, as shown by Mori,[9] by Wolbach and Howe,[10, 11] and by Wolbach and Bessey,[12] consists of metaplasia and keratinization of normal epithelium, probably occurring first in the respiratory tract,[13] but also involving the alimentary and urinary tracts as well as the eyes

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and the paraocular glands. The resulting loss of ciliated respiratory epithelium has been considered a factor in decreasing the resistance of the respiratory tract to infection. The increased incidence of respiratory infection in vitamin A depleted animals has been discussed by Clausen,[14] Robertson,[15] and by Steiner, Greene, and Kramer.[16] Respiratory infections, including bronchiectasis, occurring in many children with cystic fibrosis of the pancreas, have been described by Anderson,[17] by Farber,[18] and by Zuelzer and Newton.[19] Many of these same children demonstrate metaplasia of the respiratory epithelium associated with vitamin A deficiency, which in turn is probably a sequel of the pancreatic disease.

Consideration was therefore given to any effect which chronic cough might have on bronchi whose epithelium had been altered by vitamin A deficiency, with and without the elements of induced infection. Attempts were made to study these effects experimentally in rats, and any relationship they might have to bronchiectasis. The element of bronchial obstruction was purposely avoided.

Rats were felt to be satisfactory animals for such a study because of ease of handling and production of vitamin A deficiencies, and because they do develop bronchiectasis. Wilens and Sproul[20] studied 487 rats of an inbred strain of pure albino rats of Osborn-Mendel stock, all of which had died spontaneously at average ages of 700 to 750 days, and found bronchiectasis and lung abscesses in 75 per cent of them. Saxton, Barnes, and Sperling[21] studied the lung changes in rats of various ages, and did not find any bronchiectasis or chronic pneumonia prior to 250 days of age, with an increasing incidence of these diseases in rats above this age. All animals used in the studies to be reported were less than 250 days old at the time they were sacrificed.

EXPERIMENTS

Group I served as controls and received a regular diet consisting of the following:

Protein	24.8 per cent
Fat	4.6 per cent
Fiber	4.8 per cent
Carbohydrate	49.3 per cent
Nitrogen, free	44.4 per cent
Ash	9.5 per cent
Vitamin A	610-680

International units per 100 grams

Group II received a regular diet and was also subjected to increased endobronchial pressure of 10 centimeters of water for thirty minutes a day. The endobronchial pressure was created by using air-tight metal chambers with glass tops (Figs. 1 and 2). The front wall of each chamber was made of rubber dam, having an opening in it of such size that when the rat's head was placed through the opening, the rubber dam fit snugly about the animal's neck and did not constrict or leak at the pressures used. Movements of the rat's body were controlled by placing the animal in a lucite tube fitted with metal clamps of opposed "V" shaped which could be adjusted about the animal's neck without constriction, but prevented the rat from moving his neck too far forward or backward. The chamber containing the rat's head was connected to

a source of air pressure, and the system fitted with a water manometer to allow for accurate adjustment of pressure, and also equipped with "safety" manometers to prevent pressure in any chamber exceeding the pre-set level. The anterior chest wall was removed from a rat and it was noted that this apparatus would increase endobronchial pressure during both inspiratory and expiratory phases and give some simulation of the cough mechanism. The pressure was set empirically at ten centimeters of water, and each rat was held in the chamber thirty minutes daily from 21 to 109 days (average, 72 days).

Group III received a diet deficient only in vitamin A. (United States Pharmacopoeia XII, page 636.) The following vitamin A deficient diet was used:

Vitamin-free casein	18 per cent
Salt mixture	4 per cent
Dried yeast	8 per cent
Starch	65 per cent
Vegetable oil	5 per cent
Vitamin D	3 U.S.P.

Units per gram supplied by irradiated ergosterol

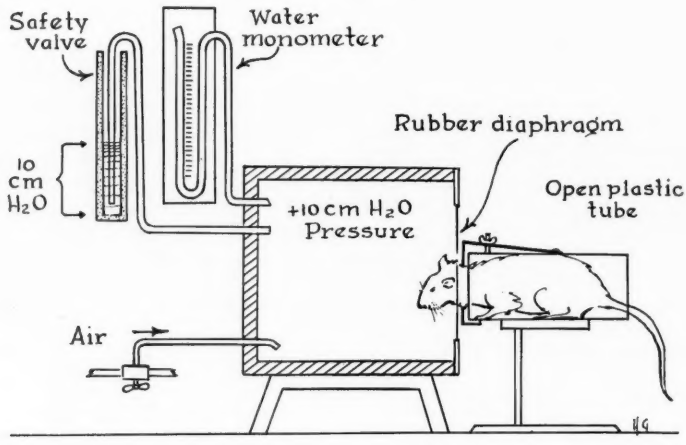

Fig. 1.—Sagittal section diagrammatically showing arrangement of animal in lucite tube with the rubber diaphragm around his neck preventing loss of air from the closed metal chamber.

The air inflow tube, water manometer, and water safety valve maintain the +10 cm. of water pressure of air upon the animal's head.

Group IV received a diet deficient in vitamin A and was subjected to increased endobronchial pressure as in Group II.

Group V received a full diet and received one nasopharyngeal instillation by pipette, of 0.25 c.c. of a suspension containing a 50 per cent pure culture of alpha streptococcus and 50 per cent staphylococcus.

Group VI was given a combination of a diet deficient in vitamin A plus the nasopharyngeal instillation of bacteria.

Group VII received a diet deficient in vitamin A, was subjected to increased endobronchial pressure and nasopharyngeal instillation of bacteria.

In the vitamin A deficient groups, the vitamin deficiency was established before the bacterial suspensions were instilled. Sixty to seventy-two days were allowed to establish the deficiency.

PATHOLOGIC CHANGES

When the animals died or were sacrificed, the trachea was immediately clamped and the lungs excised and placed in a 4 per cent solution of formalin. Sections were made at various levels through each lung and stained with hematoxylin and eosin.

Group I: (15 rats, controls.) The control group of young rats was sacrificed at average ages of 170 days, and on microscopic examination the bronchi of all were found to be normal. The lungs of three animals showed slight emphysema.

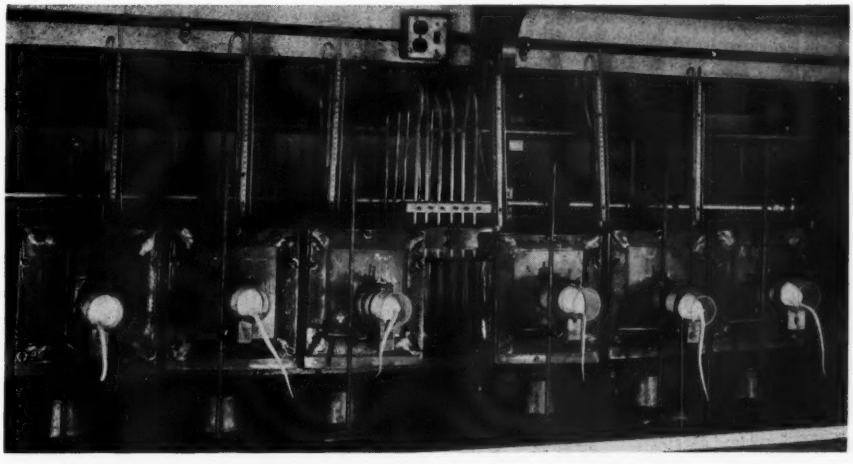

Fig. 2.—Use of a battery of lucite tubes and pressure chambers permits six animals to be exposed at one time to increased endobronchial pressures. A water manometer is seen above each chamber. The central glass jar with six tubes entering the water comprises the "safety valve" arrangement to prevent pressure in any chamber exceeding the pre-set level of 10 cm. of water.

Group II: (15 rats, regular diet plus increased endobronchial pressure for an average of 96 days.) This group showed normal bronchi with no evidence of dilatation, but the lung tissue in all showed moderate emphysema and red blood cell congestion in the pulmonary blood vessels. The layers of the bronchial walls were normal, and showed no changes which might be attributed to the increased pressure.

Group III: (15 rats, vitamin A deficient diet for an average of 79 days.) All animals showed metaplasia of the cylindrical or cuboidal type epithelium to the squamous keratinizing type, which was attributed to the vitamin A deficiency. The fibrous and muscular tissue of the bronchial walls was clearly demarcated, with no abnormality noted. Eight of the rats showed normal

bronchi and seven showed dilated bronchi. Thirteen of the group demonstrated slight to moderate emphysema and red blood cell congestion in the alveoli. Two rats showed infiltration of neutrophils in the bronchial walls along with exudate and inflammatory changes in the lung parenchyma justifying a diagnosis of bronchitis and pneumonia in each.

Group IV: (15 rats, vitamin A deficiency established and increased endobronchial pressure for an average of 66 days.) Fourteen rats showed metaplasia of the respiratory epithelium. The fifteenth animal did not demonstrate it, due probably to insufficient time (25 days) on the vitamin A deficient diet. Eleven rats showed normal bronchi and four revealed dilated bronchi, although evidence of bronchiectasis was not present in the bronchial walls. All showed emphysema and red blood cell congestion in the pulmonary alveoli in Group II.

Group V: (18 rats, regular diet and intranasal bacteria for an average of 92 days.) Bronchitis was found in only one rat in this group and there were no other significant findings.

Group VI: (19 rats, vitamin A deficiency established and intranasal bacteria for an average of 87 days.) Again there was evidence of pulmonary emphysema and red blood cell congestion in alveoli in all animals. In this group there were four animals showing evidence of bronchitis, five demonstrated pneumonia and six rats developed pulmonary abscesses. There was no evidence of bronchiectasis.

Group VII: (15 rats, vitamin A deficiency established, increased endobronchial pressure, and intranasal bacteria for an average of 83 days.) All animals showed pulmonary emphysema plus red blood cell congestion in the alveoli. Vitamin A deficiency was produced in all of the rats of this group before the bacterial suspension was introduced, and 30 to 45 days were allowed to elapse after bacterial instillation before the animals were sacrificed. There was no evidence in this group of bronchitis, pneumonia, pulmonary abscess, or bronchiectasis.

DISCUSSION

In young healthy rats, metaplasia of the respiratory epithelium, increased endobronchial pressures and bacteria instilled into the respiratory tract, did not, either singly or in various combination, under the conditions of the experiments, produce any changes in the bronchi or lungs which could be interpreted histologically as bronchiectasis. It does not rule out the possibility of achieving different results by varying the degree of duration of endobronchial pressures used, the duration of dietary insufficiency, or the quality or quantity of bacterial installations. However, any results obtained in rats more than 250 days old would be difficult or impossible to interpret. Goldblatt and Benischek[22] have found that vitamin A deficiency alone may produce infection and abscess in the bronchioles of rats due to blockage by the keratinized cells which have been shed from the walls. Pulmonary infections then may occur from the bacteria already normally present at the site, bacterial growth being favored by poor drainage, dead tissue and the lack of ciliary action and metaplasia

TABLE I

GROUPS	NO. OF RATS	BRONCHI NOT DILATED	DILATED BRONCHI	EMPHYSEMA	RED BLOOD CELL CONGESTION	BRONCHITIS	PNEUMONIA	PULMONARY ABSCESS	VITAMIN A DEFICIENCY	BRONCHIECTASIS
I. Regular diet (controls)	15	15	0	3	0	0	0	0	0	0
II. Regular diet and increased endobronchial pressure	15	15	0	15	15	0	1	0	0	0
III. Vitamin A deficient diet	15	8	7	14	14	2	2	0	15	0
IV. Vitamin A deficient diet and increased endobronchial pressure	15	11	4	15	15	0	0	0	14	0
V. Regular diet and nasopharyngeal bacteria	18	16	2	4	0	1	0	0	0	0
VI. Vitamin A deficient diet and nasopharyngeal bacteria	19	16	3	13	17	4	5	6	19	0
VII. Vitamin A deficient diet, increased endobronchial pressure and nasopharyngeal bacteria	15	8	7	15	15	0	0	0	15	0

and mucus secretion which are the sequelae of the metaplasia. Two animals in Group III that were on the vitamin A deficient diet alone showed bronchitis and pneumonia but no evidence of bronchiectasis.

All rats subject to increased endobronchial pressure did develop some degree of pulmonary emphysema, even though rats in all other groups, not subject to increased endobronchial pressures, also showed varying incidences of emphysema (Table I). Such findings would tend to support the opinion expressed by Andrus[1] that the forces active in coughing may be so distributed as to cause pulmonary emphysema.

Of the three groups of animals receiving bacterial installations, the group on normal diet showed the least change, only one animal developing evidence of bronchitis. In the group with vitamin deficiency alone, more changes occurred following installation of bacteria than in the group with vitamin deficiency plus elevated endobronchial pressures. Why such a difference should occur is not clear. Tannenberg and Pinner,[6] using rabbits, introduced infectious material into the bronchi distal to the point of bronchial ligation, and demonstrated severe bronchiectatic changes in the lung distal to the bronchial obstruction, while the opposite lung showed extensive bronchopneumonia.

In all animals used here, the element of bronchial obstruction was purposely avoided, and the absence of bronchiectasis in these rats would tend to lend evidence in support of the theory that complete or partial bronchial obstruction, probably plus infection are essential to the production of bronchiectasis. The findings would further tend to favor the opinions of Farber[18] and of Zuelzer and Newton[19] that in the production of bronchiectatic changes in the lungs of children with cystic fibrosis of the pancreas, the blockage of bronchioles by thick, tenacious mucus is probably a more important factor than the metaplasia of the bronchial epithelium.

SUMMARY

1. Metaplasia and keratinization of the bronchial epithelium could be produced in young healthy rats by the use of vitamin A deficient diet.

2. The effects of the three following factors: (a) metaplasia of bronchial epithelium, (b) elevated endobronchial pressure (10 cm. of water elevation for thirty minutes daily over average periods of 72 days), and (c) nasopharyngeal instillation of bacteria (0.25 c.c. of a suspension of equal parts of alpha streptococci and staphylococci introduced once) were studied in young healthy rats, singly and in various combinations. Various degrees of pulmonary emphysema were produced, along with a few instances of bronchitis and lung abscesses, but there were no histologic changes in the lungs of any of the animals to suggest that bronchiectasis had been produced.

3. The absence of bronchiectasis in the rats studied would seem to lend evidence in support of the theory that complete or partial bronchial obstruction, probably plus infection, are essential to the production of bronchiectasis.

The authors wish to express their grateful appreciation to Dr. Grant Ashley and Edward Patterson for their assistance in this work.

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TRANS-STERNAL TRACHEAL EXCISION FOR CARCINOMA

Report of a Case

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THE successful treatment of obstructive lesions of the mid-trachea is rendered difficult because of the presence of the overlying great vessels and sternum. Heretofore, for the management of tracheal neoplasms we have had to rely on the incomplete endoscopic removal of the endotracheal portion of the growth or on the doubtful effect of roentgen therapy on lesions of a type which commonly show little response. The following case report demonstrates the feasibility of applying the principles of surgery for malignant lesions to this part of the body. Only one similar instance could be found in the literature.[1]

J. S. B., a 62-year-old retired white rural mail carrier, first noted hoarseness about Dec. 1, 1948, ten weeks before admission, following an upper respiratory infection. This hoarseness continued with a "raw" feeling in the throat and slight discomfort on swallowing. The patient's general health was excellent. He had become slightly deaf in the last few years; there had been the usual childhood diseases; he had had repair of inguinal hernia in 1912 and an appendectomy in 1937. He was a heavy smoker and an occasional heavy drinker. Otherwise his history was negative.

Laryngoscopic examination under topical anesthesia with pontocaine was performed on Feb. 9, 1949, at which time a whitish tumor mass was found which was situated on the right vocal cord, occupying its entire length and jutting into the posterior commissure. A biopsy of this lesion revealed it to be epidermoid carcinoma, Grade I-II. The patient was admitted to the University of Virginia Hospital on Feb. 17, 1949. On physical examination he was found to be a slender but well-developed elderly white man. The only significant findings were moderate hypertrophy of the tonsils, a few shotty cervical nodes, and a moderate systolic hypertension. The blood Wassermann and Kahn tests were negative. The urine was negative. The blood urea was found to be 17 mg. per cent. The plasma protein was 6.7 Gm. per cent. The hemoglobin was 13 Gm. per 100 cubic centimeters (84 per cent), and the red blood cell count 4.45 million per cubic millimeter. The white blood cell count was 13,000 per cubic millimeter, and the differential count was normal.

On Feb. 18, 1949, a total laryngectomy was performed under anesthesia with intravenous sodium pentothal supplemented by local infiltration of 1 per cent procaine. The pathologist reported: "Epidermoid carcinoma of the larynx, Grade I-II, involving the left vocal cord, the left elastic cone, and the posterior commissure." The patient had an uncomplicated convalescence, and left the hospital on March 1, 1949. He returned on March 9, 1949, with labored respirations, and a crust of inspissated mucus was found and removed, with immediate relief. On repeated check-up examination he was found to be doing well except for slight crusting of the tracheostomy, until Nov. 17, 1949, when a slightly piled-up gray elevation was noted 1 cm. within the tracheal ostium, on the patient's left and anteriorly. Biopsy was reported as epidermoid carcinoma. On Dec. 1, 1949, five radon seeds were implanted anteriorly after removal of recurrent neoplasm with cup biopsy forceps.

On Jan. 19, 1950, visible tumor tissue was seen projecting into the trachea from its anterior wall 4 cm. within this area, which discharged a small amount of serosanguineous material. He was admitted the following day for roentgen therapy which was administered between

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Jan. 21, 1950, and Feb. 7, 1950, to a total of 3,400 r over the upper sternum, suprasternal notch and tracheostomy site with the following factors: 200 kv., F.S.D. 50 cm., 25 Ma., H.V.L. 1 mm. copper. Roentgenograms of the chest showed a moderate amount of emphysema with some flattening of the diaphragm. The aorta contained much calcium, and the radon seeds implanted Dec. 1, 1949, were visualized as small opacities overlying the fourth dorsal vertebra. There was no evidence of osseous or parenchymatous metastases. At the time of discharge on Feb. 8, 1950, there was a marked hyperemia of the skin in the treated areas and some recession of the visible tumor. On March 30, 1950, there was some limitation of the airway, which had progressed by April 27, 1950, to the point where the laryngectomy tube could not be inserted. By May 11, 1950, the tracheal stenosis had become marked and the patient was again admitted. Examination showed him to be using accessory muscles of respiration. The tracheostomy site was surrounded by a slightly elevated rim of firm tissue. The neoplasm was visible within the ostium as a grayish-red, granular, firm projection from the lateral walls, particularly the right, which extended down the trachea for a distance of 3 to 5 cm. and reduced the airway to a vertical slit 2 mm. in width. No cervical or supraclavicular nodes were palpable, and the tracheostomy and recurrence were freely movable. Roentgenograms of the chest showed no change from the previous study of March 30, 1950.

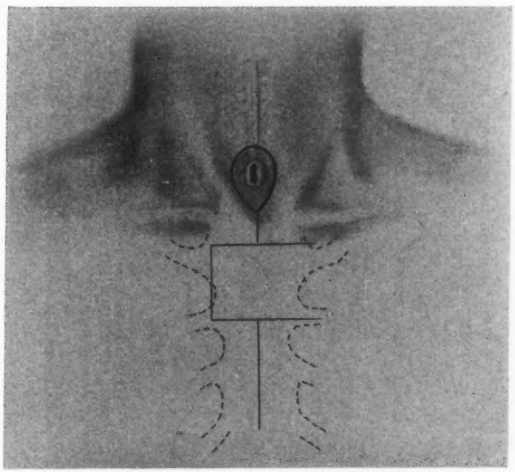

Fig. 1.—Outline drawing of skin incision.

The thoracic consultant felt that: "Although operation may be highly dangerous because of the extensive irradiation, a laissez-faire policy will certainly be fatal within a few weeks. Since there is no evidence of metastases and since asphyxia is inevitable, we feel that a tracheoplasty through the divided sternum may remove the neoplasm and restore the airway." On May 15, 1950, an anterior mediastinotomy with removal of the upper trachea and trans-sternal tracheoplasty was carried out. The operative note, except for an initial paragraph containing a brief history and the indication for operation, follows.

"Anesthesia was induced with intravenous pentothal, following which a rather small intratracheal tube was inserted through the tracheostomy opening and anesthesia continued with ether-oxygen. The anterior surface of the neck and chest was prepared and draped. A rectangular skin flap was outlined over the manubrium, with its base about the level of the left first interspace. This was dissected up and preserved with a saline

sponge, with the aim of constructing a skin tube if the remaining normal trachea should not be long enough to reach the skin over the sternum. An incision was then extended over the midsternum and downward nearly to the xiphoid and upward to encircle the tracheostomy (Fig. 1). The suprasternal notch was cleared of areolar tissue between the heads of the sternocleidomastoid muscles and the index finger inserted into the anterior mediastinum. The sternum was split longitudinally with the Lebsche knife. The thyroidea ima vein was divided between ligatures close to its entrance into the left innominate vein. This latter structure was later divided between ligatures and suture ligatures to expose the innominate artery and left common carotid artery as far down as the point where they originated from the arch of the aorta. The trachea was located in the V-shaped cleft between these arterial structures. The intratracheal tube was now removed, the trachea thoroughly suctioned, and a sterile intratracheal tube reinserted on

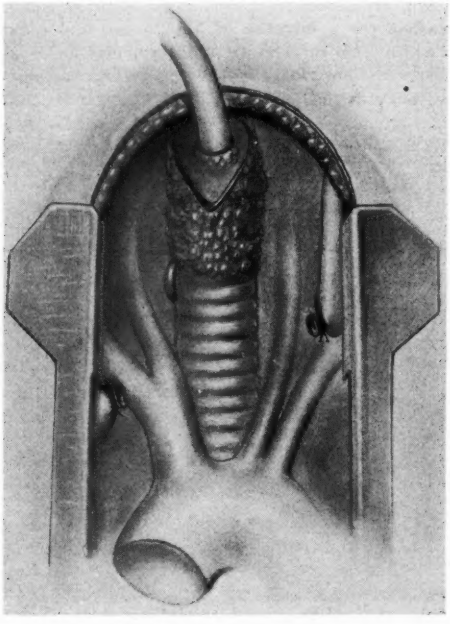

Fig. 2.—Sketch showing the relationship of the tumor-bearing upper trachea to the neighboring vascular structures.

the operator's side of the screen. This was connected by rubber tubing to the anesthesia machine over the top of the screen. This allowed the tracheostomy to be encircled and the tumor-bearing portion of the upper trachea was gradually freed of its surrounding fibrous and muscular attachments (Fig. 2). The right lobe of the thyroid was cut away from its attachment to the upper trachea which was then carefully elevated and dissected free posteriorly from the anterior hypopharynx. It was felt that during this dissection all the tumor was removed. The tumor apparently extended for about 5 cm. down the trachea from its external opening. On the right lateral side of the trachea just below the thyroid two large succulent nodes were dissected out with the trachea which was now elevated between the innominate artery and the left common carotid artery almost as far down as the bifurcation. Semicircular openings in the lower manubrium were ronguered away so that when the sternum should be pulled together, an adequate opening

through its central portion would be present to allow the emergence of the trachea to the skin (Fig. 3). At a point about 1 cm. below the lower portion of the recurrent carcinoma, the trachea was attached on both sides to the inner periosteum of the sternum with interrupted sutures of No. 36 steel wire. The tumor-containing portion was now am-

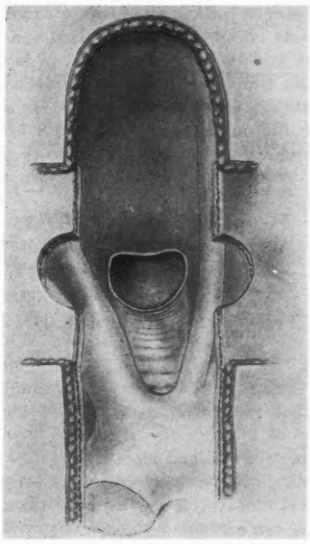

Fig. 3.—Drawing of the mobilized trachea after ablation of the tumor and preparation of the semicircular openings in the manubrium.

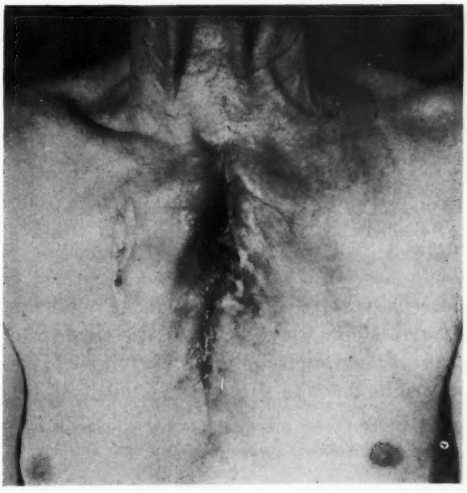

Fig. 4.—Appearance of patient six weeks after tracheal excision.

putated. From this point on, anesthesia was given intermittently by inserting a clean intratracheal tube into the trachea. The prepared flap of skin on the left was approximated to the trachea with interrupted double zero chromic catgut sutures over two-thirds of the circumference of the trachea on the left. The sternum was now drawn together with a few interrupted No. 30 steel wire sutures in the anterior periosteum and a flap of skin prepared on the right side which was then used to complete the skin tube through the sternum. An attempt was made to close the dead space previously occupied by the upper portion of the trachea and the skin was closed in layers above and below the new tracheostomy. Penrose drains were left in the substernal space and in the upper mediastinum at the base of the neck. Two areas left bare of skin were then covered with split thickness grafts taken from the anterior thigh; a No. 8 laryngectomy tube was inserted into the new tracheostomy and a dry dressing applied to the wound. The patient tolerated this extensive procedure quite well and left the operating room with a clear airway and in excellent condition.''

The report of the Department of Pathology read as follows: ''A tubular section of the trachea which measured 5 cm. in length and 3 cm. in diameter. Seven cartilaginous tracheal rings are included. The surface is covered with grayish fibrous adhesions and attached to one side near the distal end is an ovoid soft grayish nodule 1 by 1 by 1.5 cm. The wall of the trachea varies from 3 to 7 mm. in thickness and includes several areas of firm grayish-white tissues suggestive of carcinoma. The mucosal surface is slightly wrinkled and gray beneath which are friable, necrotic-appearing pockets 4 to 5 mm. across, which contain three yellow radon seeds. Following a microscopic description the final diagnosis was: recurrent epidermoid carcinoma of the trachea with negative lymph nodes, adequately excised.''

The patient was given antibiotics and high caloric tube feedings, and was ambulatory on the first postoperative day. His course was satisfactory until May 26, the wounds healing nicely and the grafts showing a 90 per cent take. On that date, the thoracic resident's note says: ''The trachea seems adequately anchored. There is some slough of the skin edges and considerable sticky exudate.'' On May 31, the wound was inflamed, and purulent exudate emerged from between the divided sternum. The airway was satisfactory, although there was considerable crusting of the upper trachea. The patient was kept in a small room with a croup kettle, but he still complained of dryness of the air and himself arranged a protecting framework of wire covered with flannel which he placed over the tracheostomy and kept moist with water.

By June 28 he had learned to care for the tracheostomy, which was now freely patent without the tube. The wound had improved greatly in appearance, and drainage was not more than 15 to 25 c.c. daily (Fig. 4). The temperature was usually between 99 and 100° F. He was discharged at this time but returned July 3, 1950, inebriated. There had been progressive improvement of the wound and it was felt that the sternum eventually might heal completely. He was discharged July 8, 1950.

Efforts were made to have this man return for check-up examinations, but no more was heard of him until the report of his death Sept. 30, 1950, at home from what was apparently a sudden large hemorrhage from within the substernal space.

SUMMARY

This report describes the recurrence following total laryngectomy for epidermoid carcinoma of a similar lesion within the tracheostomy. Whether this was an extension, an implantation, or the occurrence of a totally separate primary cannot be determined. The surgical treatment of this lesion and its sequellae have been described.

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ENDOBRONCHIAL CARCINOSARCOMA

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THE term carcinosarcoma denotes a mixed tumor containing the elements of carcinoma and sarcoma. Whether such an entity actually exists is a matter of controversy.

When faced with such critical reviews as those of Saphir and Vass[6] and Willis,[7] one hesitates to use this term in classifying a neoplasm. However, we wish to report two identical and unusual endobronchial tumors which show a similar histologic appearance, being composed predominantly of spindle cells simulating a fibrosarcoma intermixed with which are scattered islands of obvious squamous-cell carcinoma. These tumors appear to be quite distinctive, and in our opinion should be separated from the usual bronchiogenic carcinomas.

CASE REPORTS

Case 1.—A white man, aged 69 years, complained of a persistent dry cough, general malaise, and fever of two months' duration. He claimed to have aspirated a cough drop during sleep, following which he had tightness in the chest and dyspnea. There was no hoarseness, chest pain, or hemoptysis, but his cough and dyspnea increased. He had always lived a healthy outdoor life and had no medical consultations except for a gunshot wound of the arm in World War I and a prostatectomy eleven years previously. He was a heavy cigarette smoker and used alcohol infrequently. Physical examination showed restricted movement of the right side of the chest with dullness to percussion and diminished breath sounds which were almost absent over the base. The trachea was shifted slightly to the right.

Roentgenogram.—There was atelectasis of the right lower and middle lobes.

Laboratory Examinations.—Vital capacity was 1,500 c.c.; white blood count 10,700 per cu. mm.; sedimentation rate varied from 71 mm. to 109 mm. per hour (Westergren); sputum was negative for acid-fast bacilli and for tumor cells; cultures gave a growth of *Streptococcus hemolyticus.*

A bronchoscopy was performed and revealed the right main bronchus to be plugged with brownish necrotic tissue considered to be a bronchogenic carcinoma. A biopsy from this showed only chronic inflammatory and necrotic tissue interpreted as being related to the aspirated cough drop. Following penicillin, a further bronchoscopy was performed seven days later and showed a red fungating tissue filling the right main bronchus. Several portions were removed, weighing in all 4.5 grams. Sections of this tissue showed a tumor of sarcomatous appearance consisting of interlacing fasciculi of coarse spindle cells with large nuclei, prominent nucleoli, many mitoses, and some tumor giant cells. This was interpreted as a sarcoma, possibly of neurogenic origin. Pneumonectomy was performed three months after the onset of his symptoms. No pleural adhesions were found, and the middle lobe was atelectatic.

Surgical Specimen.—This consisted of the entire right lung; the pleural surfaces were smooth. The upper lobe was aerated, the middle and lower lobes were atelectatic. In the major bronchus was found an elongated cigar-shaped pedunculated soft rubbery, grayish-red tumor 4 by 1.5 by 1 cm. It was entirely endobronchial, and its only attachment was

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a small short pedicle from its midportion to the lower-lobe bronchus, the tumor extending both up and down from the pedicle, its upper limit covering the bronchial aperture to the middle lobe but did not enter it. The lower extremity formed a firm plug in the lower-lobe bronchus beyond which pus filled the lumen.

Microscopic Examination.—The main part of the tumor lay within the bronchial lumen, but the tumor pedicle protruded through an intercartilaginous space forming a small buttonlike knob with a discrete condensed capsulelike border lying against normal lung alveoli. Much of the surface was necrotic and ulcerated (Fig. 1). The tumor was very cellular and consisted of two distinct elements, fibrous stroma and squamous epithelial islands, both of which showed active growth and were intermixed. The main bulk of the tumor consisted of broad sheets of spindle cells with fasciculation (Fig. 2). There was much variation in size and shape with fusiform spindle cells, short oval cells, and stellate cells with long processes (Fig. 3). The nuclei were large, oval, pale, and vesicular, with prominent single and multiple nucleoli. Numerous pyknotic nuclei and bizarre mitoses

Fig. 1.—(Case 1) Low-power view to show entire tumor. The elongated upper portion was largely fibrosarcomatous (Figs. 2 to 4), with occasional areas of carcinoma, the latter being predominant in the base (Figs. 5 and 6). (Hematoxylin and eosin ×4.)

were evident, with multilobed nuclei and occasional tumor giant cells. Sections impregnated with silver showed distinct reticulin fibrils intimately associated with these cells (Fig. 4). The blood channels were fine slits lying adjacent to the tumor cells. In the base of the tumor were areas of obvious squamous carcinoma embedded in the mesoblastic tissue (Fig. 5). These areas were small, circumscribed, well demarcated, and often separated by a slitlike space from the stroma. Stratification of cells was well marked, with some cornification and pearl formation. A few areas were less differentiated, and here the cells were larger, darker, more pleomorphic, and immature, with atypical mitoses. These latter areas were less discretely separated from the stroma and in a few areas tended to blend very intimately with the stromal cells (Fig. 6). The bronchial lymph nodes were enlarged and hyperplastic but there was no invasion by tumor.

Follow-up.—The patient was discharged six weeks after operation, and three years later is still well, complaining only of dyspnea. There is no evidence of recurrence or metastases.

CASE 2.—A white man, aged 57 years, consulted his doctor because of increasing dyspnea, pain in the chest, and occasional hemoptysis of some two months' duration. He had lost about 20 pounds in the previous month. Examination revealed diminished expansion of the left chest with dullness to percussion and absent breath sounds. Radiologic examination showed atelectasis of the left lung, probably due to bronchial obstruction. Bronchoscopic examination revealed a mass in the left major bronchus, and a biopsy was taken. Microscopically, however, this showed only mucus with a small piece of bronchial

Fig. 2.

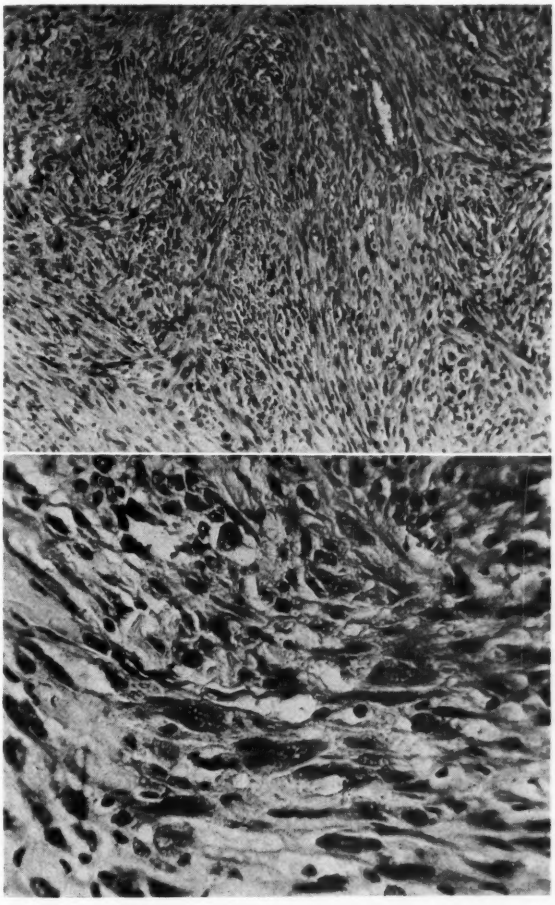

Fig. 3.

Fig. 2.—(Case 1) Fibrosarcomatous area of neoplasm showing interlacing fasciculi of spindle cells. (Hematoxylin and eosin ×100.)

Fig. 3.—(Case 1) High-power view of an area from Fig. 2 to show cell details and fibrils. (Hematoxylin and eosin ×430.)

mucosa, no neoplastic tissue being present. Seventy-two hours later he suddenly became dyspneic and shocked. He expectorated large quantities of blood and, in spite of resuscitative measures, he failed to rally and expired eight hours later.

Necropsy Findings.—Thorax: The pleural cavities were dry, and no adhesions were present. The trachea contained thin frothy blood-stained fluid. The left major bronchus was completely filled with clotted blood, forming a cast. When this was removed there was found a pedunculated tumor arising from the posterior wall of the left main bronchus just proximal to the bifurcation of the upper and lower branches. It measured 2.0 by 1.0 cm., and was attached to the wall of the bronchus by a wide base. On sectioning the tumor appeared to be entirely endobronchial, there being no extension into the adjacent lung parenchyma. *Lungs:* The lungs showed acute edema, and there was an acute suppurative bronchiolitis distal to the tumor. The bronchial and mediastinal lymph nodes showed no gross tumor infiltration. The remainder of the necropsy showed no further lesions.

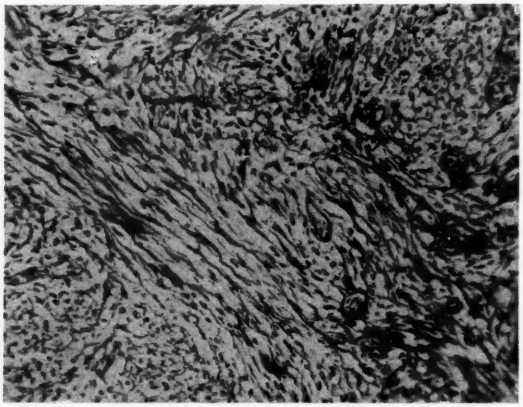

Fig. 4.—(Case 1) This shows the marked reticulin formation by the spindle cells in the fibrosarcomatous area of the neoplasm. (Silver impregnation, Wilders method ×100.)

Microscopic Examination.—Bronchial tumor: This had a pedunculated appearance similar to Fig. 1, the main tumor projecting into the lumen of the bronchus. The vast majority of the neoplasm was very cellular simulating a sarcoma, being composed predominantly of spindle cells, many having irregular bizarre nuclei (Fig. 7). In many areas the cells were arranged in bands and interlacing fasciculi. In other areas they had a haphazard arrangement with, here and there, a larger tumor giant cell. Masson stains showed delicate collagen fibrils intimately associated with the spindle cells (Fig. 8). At the base of the neoplasm between the cartilaginous plates, the picture was quite different. Here were nests of typical squamous-cell carcinoma (Fig. 9), most of which were well differentiated, many of the clusters showing polygonal keratinized cells with an occasional small epithelial pearl. Many of the nests lay in a space, an occasional one being lined with flattened endothelial cells suggesting lymphatics. Separating these neoplastic masses was dense, acellular collagen. Serial sections failed to show any transition between the obvious carcinoma and the cellular sarcomatous areas. *Lymph nodes* and *all other tissues* failed to show any evidence of metastatic tumor.

DISCUSSION

These two tumors are characterized by an admixture of apparent fibrosarcoma and squamous-cell carcinoma. In Case 1 a few areas were found in which the carcinomatous tissue faded into the sarcoma, suggesting that the

latter might be a bizarre spindle-cell variant of squamous carcinoma. It is well known that such a transition may be seen, but in most instances this type of tumor is quite obvious. Such is not the case here, for if one views the spindle-cell areas of these tumors alone, one is forced to interpret these regions as fibrosarcoma, the neoplastic cells showing a distinct reticulin and collagen fibril formation. Further, in Case 2 we were unable to show in serial sections any transition between the carcinoma and the spindle-cell areas. Some of the bi-

Fig. 5.

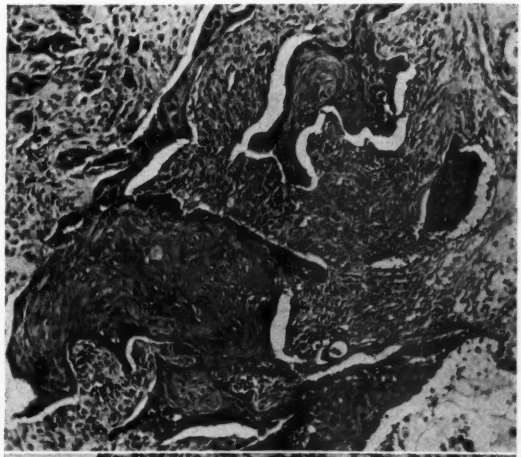

Fig. 6.

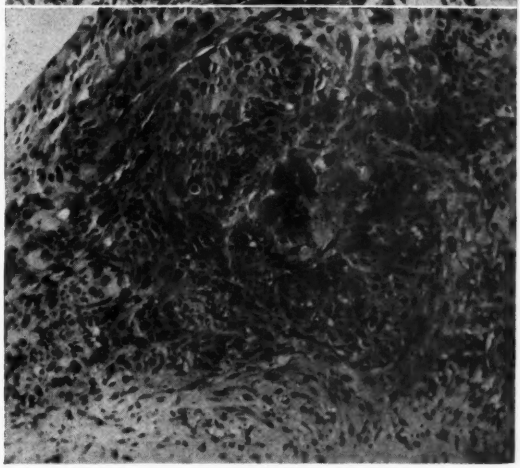

Fig. 5.—(Case 1) An area from the base of the tumor showing islands of squamous carcinoma. Here the sheets of carcinoma cells are separated from the stroma by clear spaces. (Hematoxylin and eosin ×100.)

Fig. 6.—(Case 1) Another area showing less differentiated squamous carcinoma with variations to spindle cells. The latter, however, are dissimilar to the sarcomatous areas depicted in Figs. 2 and 3. (Hematoxylin and eosin ×100.)

zarre tumor giant cells interspersed in the sarcomatous areas do, however, have an epithelial appearance and probably represent an admixture of carcinomatous cells in the predominantly sarcomatous regions.

Saphir and Vass,[6] in their classical review of 153 cases designated as "carcinosarcoma," accept only three or four examples as true instances. The majority they interpret as examples of primary carcinoma showing areas in which the carcinomatous cells have assumed a spindle character simulating sarcoma. Seven of the cases reviewed by them involved the lung, but they accepted only one instance of a mucinous adenocarcinoma with associated spindle and pleomorphic cells as a possible example of carcinosarcoma. Willis,[7] while accepting examples of carcinosarcoma in animals, knows of no indubitable example of this neoplasm in human material. Foulds,[2] in his review, offers several explanations to explain complex tumors with multiple neoplastic components including an intermingling of independent primary tumors; the possibility of simultaneous

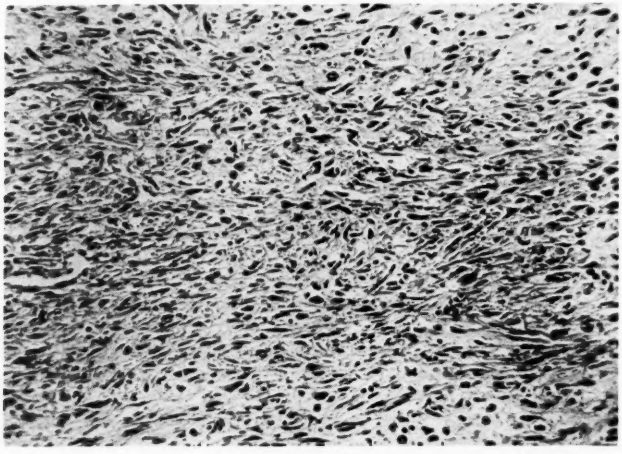

Fig. 7.—(Case 2) Fibrosarcomatous area of tumor showing bizarre spindle cells with hyperchromatic irregular nuclei. The main mass of the tumor had this appearance. (Hematoxylin and eosin ×120.)

neoplasia in two closely associated tissues, e.g., parenchyma and stroma; or neoplasia of stroma or invaded tissues in a primarily simple tumor. Foulds unfortunately does not give any clear-cut opinion of his own on this subject, his paper being primarily a review in which he largely cites other authors' opinions.

On the other hand, Harvey and Hamilton[3] have suggested that carcinosarcomas might result from sarcomatous change in the stroma of a carcinoma. More recently, Bergmann, Ackerman, and Kemler[1] have reported two tumors that appear to be identical to those described here, and they have interpreted them as true examples of carcinosarcoma. In a review of the literature they consider eight other reported tumors from the lung to belong in this group, and a further four to represent "collision tumors." They also cast some doubt upon the high rejection rate of carcinosarcomas by Saphir and Vass.

We have been unable to find examples of similar tumors, other than those included in the review by Bergmann and his associates. Rock and Hall[5] have reported a case of squamous-cell carcinoma of a bronchus and spindle-cell sarcoma of the lung, but this they interpreted as multiple primary tumors rather than a true carcinosarcoma.

Fig. 8.

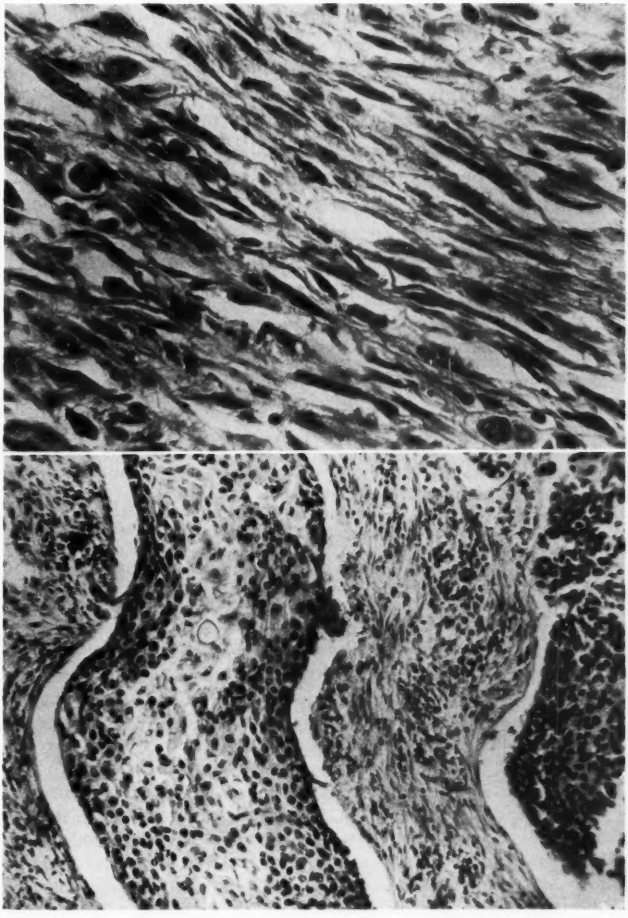

Fig. 9.

Fig. 8.—(Case 2) High-power view of an area from Fig. 7 to show collagen fibrils being formed by spindle cells. (Masson's trichrome stain ×400.)

Fig. 9.—(Case 2) An area from the base of the tumor showing squamous carcinoma. The stroma here is not neoplastic. (Hematoxylin and eosin ×120.)

In view of the distinctive histologic appearance of these tumors, we are of the opinion that they should be classed separately as endobronchial carcinosarcomas. Furthermore, their clinical behavior and prognosis appear to warrant

this separation. One of our cases is living and well three years after pneumonectomy, while one of Bergmann's cases has survived six years and the other one year and seven months at the time of the report. In this respect they resemble sarcoma of the lung. As Iverson[4] has stated, "The patient is equally fortunate in having a sarcoma of the bronchus or its imitator carcinosarcoma in lieu of a classical bronchogenic carcinoma."

SUMMARY

1. Two distinctive endobronchial tumors have been reported, composed of spindle-cell fibrosarcomatous areas with intermixed squamous-cell carcinoma.

2. These are interpreted as true carcinosarcomas rather than squamous-cell carcinomas showing transition to a spindle-cell variant.

3. These tumors appear to have a better prognosis than bronchiogenic carcinoma. One patient is living and well three years after pneumonectomy. The other, who died of massive hemorrhage following bronchoscopic biopsy, showed no evidence of metastases or extension to the lung at necropsy.

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WOUND OF THE SUPERIOR VENA CAVA WITH SURVIVAL

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WOUNDS of the great vessels in the mediastinum are so deadly that there are almost no recorded cases of such wounds with survival. Prior to the present time there has been but one record of a patient who survived a wound of the superior vena cava. In 1933 Biggers[1] reported the case of a patient who had been stabbed in the right chest, the blade entering near the sternum at the level of the third intercostal space, with rapid development of symptoms of cardiac tamponade. A diagnosis of probable wound of the right auricle was entertained, and the patient was explored through an anterior incision. The pericardial sac was tense with blood and bore a small rent over the region of the right auricle. This rent was enlarged, and a large gush of blood occurred. Digital pressure within the pericardium controlled the active bleeding, and a wound of the intrapericardial portion of the superior vena cava was eventually located. It was successfully closed with interrupted sutures, and the patient survived.

The case reported here is different in that the tear in the vena cava occurred above the pericardial reflection, and was located in such a position as to section the phrenic nerve. The effect of this difference was that it permitted a much greater immediate loss of blood with the dangers inherent to exsanguination and excessive mediastinal shift.

CASE REPORT

A 43-year-old woman was hit at virtually point-blank range by a bullet from a .38 caliber pistol. The slug entered the right chest just below the first rib cartilage, immediately to the right of the sternum. It emerged posteriorly just to the right of the spine at the level of the sixth posterior rib. When brought to the hospital* at 2 A.M. she was desperately short of breath and in a state of shock. Physical examination revealed two cleanly drilled bullet holes in the location described above. There were dullness and absent breath sounds over the entire right hemithorax, and the apex beat of the heart was shifted far to the left. Portable roentgenogram of the chest showed a complete blank-out of the right lung and a great shift of the mediastinum to the left. Also shown was complete section of the sixth rib near the spine with tiny fragments of lead left clinging to the ends of the broken bone (Fig. 1).

Whole blood, plasma, and vasopressor drugs were quickly given to combat the threatening state of shock and gradually, over the course of a few hours, the condition of the patient became relatively stable so that she was reasonably comfortable with oxygen administration. Some eighteen hours after the injury she was seen in consultation. She was very dyspneic and apprehensive. There was a large quantity of blood in the bed, the result of leakage from the posterior wound of exit. An attempt was made to aspirate the pleural space with a large needle, but this was impossible due to clot formation. When asked to cough, as she was sitting upright, a gush of air and blood came from the posterior wound. At this point the blood pressure was falling and it was obvious that thoracotomy was indicated.

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*Delnor Hospital, St. Charles, Ill. Service of Dr. Norman J. Schreiber.

Under endotracheal ether-oxygen anesthesia, the right chest was opened through a posterolateral incision resecting the already fractured sixth rib. A large quantity of liquid and clotted blood was evacuated from the pleural space, and it was then noted that the right diaphragm did not move with respiration. The lung was retracted posteriorly, and the anterior mediastinum was inspected. Just above the point where the azygos vein entered the superior vena cava a rent measuring about 1.5 cm. was seen in this vessel. The phrenic nerve was cleanly sectioned at this point. The tear in the vena cava was precariously closed by a soft, friable clot so that at the moment of inspection only minimal bleeding was taking place (Fig. 2).

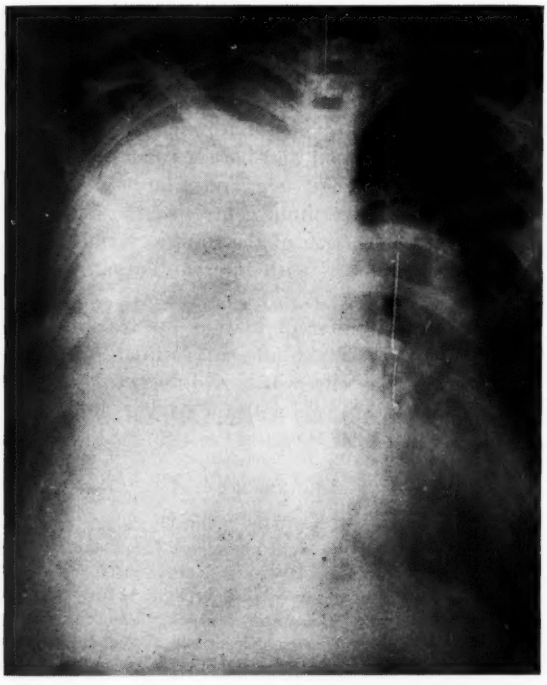

Fig. 1.—Portable chest film taken soon after injury showing massive collection of pleural fluid (blood) on right and severe shift of heart and mediastinum to left.

The bullet had passed through the upper lobe and the superior segment of the lower lobe close to the mediastinum so that there were four small holes in the lung. These were not bleeding, and the pulmonary tissue was not shattered. The wounds in the lung were closed with deeply placed sutures of No. 1 plain catgut while vascular suture material was being made ready. When these were on hand the clot was wiped off the tear in the vena cava. The brisk bleeding which followed was readily controlled by pressure of the index finger during the application of three Allis clamps (Fig. 2—insert). These clamps did not, of course, occlude the lumen of the vessel, but merely approximated the cut edges of the wound. The wound was then sutured with a simple running suture of 00000 silk on an atraumatic needle. As the suture progressed along the tear the clamps were removed, one at a time. No further bleeding occurred.

The chest was closed in layers leaving one posterior drain attached to a water trap during the closure. Gentle positive pressure through the endotracheal tube re-expanded

the lung and trapped the air out of the pleural space. The patient was returned to her room in much better condition than when she left it. Her convalescence was uneventful except for a temperature of 105° F. on the second postoperative day. This was not explained, since there was no clinical nor laboratory evidence of transfusion reaction, and

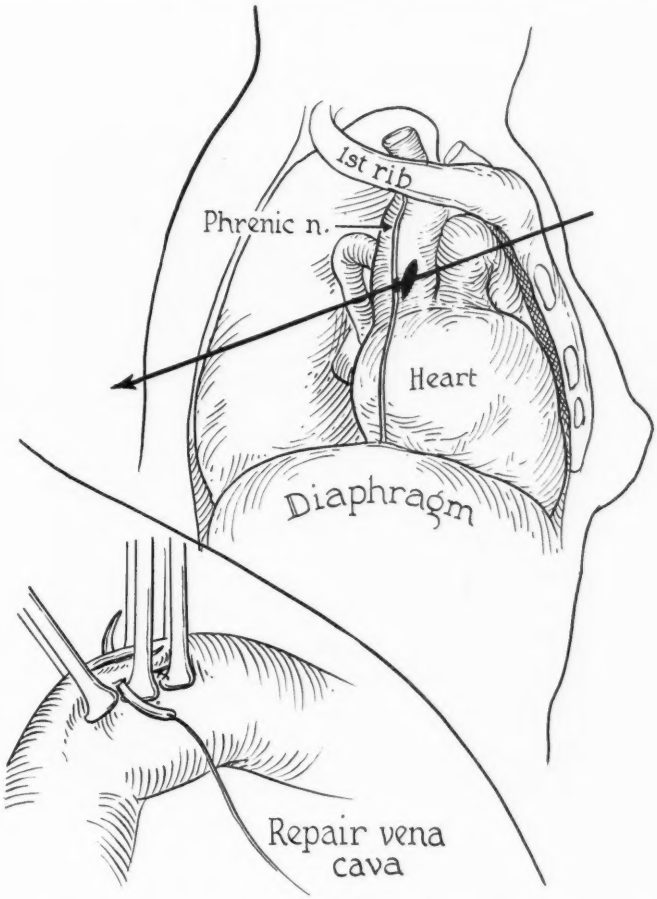

Fig. 2.—Wound in the superior vena cava with section of phrenic nerve. *Insert:* Method of repair. Artist has shown interrupted suture whereas actual closure was done with running suture.

since she always raised her pulmonary secretions quite well. She was discharged on the tenth day after operation. Fluoroscopy on the day of discharge from the hospital showed total paralysis of the right leaf of the diaphragm. A roentgenogram taken two weeks later (Fig. 3) showed the right lung well aerated, and a marked rise of the right diaphragm.

COMMENT

Certainly wounds of the superior vena cava will practically always be fatal. It seems likely that the fortuitous clot formation on the wound in the

vessel saved this patient's life. The rapid filling of the right pleural space no doubt brought about a state of equilibrium between the increased intrapleural pressure and the lowered pressure in the vena cava so that the clot could form presenting a barrier to further bleeding. It is interesting to speculate, in retrospect, what would have happened had the pleural blood *not* been clotted so that aspiration could have been done. It seems very likely that, with reduction of pressure in the pleural space by the withdrawal of fluid blood, the clot would have blown off allowing further, and doubtless fatal, hemorrhage.

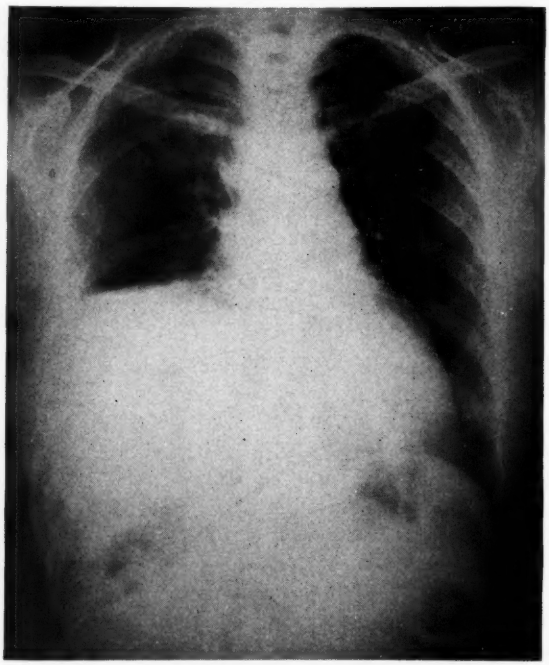

Fig. 3.—Chest film two weeks after injury showing marked rise of right diaphragm following section of phrenic nerve by bullet.

SUMMARY

A case of gunshot wound of the superior vena cava and section of the phrenic nerve with survival is reported.

REFERENCE

1. Biggers, I. A.: Wound of the Superior Vena Cava Treated by Suture, Arch. Surg. 27: 392-394, 1933.